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PROGRAMMES DRIVING THE SUSTAINABLE FUTURE

Evaluation of Bio and Circular Finland, Sustainable Manufacturing, and Smart Energy programmes of Business Finland

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BUSINESS FINLAND
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FOREWORD

Finland has long been a forerunner in sustainability, and as a proactive player in this field, Business Finland has made significant contributions by launching and managing several strategic programmes over the years. These initiatives have provided vital funding and played a key role in building business capacity, boosting exports, developing expertise, and fostering networks and collaborative platforms.

This evaluation focuses on three of Business Finland's recent programmes, all with a strong emphasis on sustainability: Smart Energy (2017–2021), Bio and Circular Finland (2019–2022), and Sustainable Manufacturing (2020–2023). Notably, these were among the first full-scale programmes of Business Finland to integrate R&D funding with a broad spectrum of export promotion and investment attraction services. As such, this evaluation also serves as an early demonstration of Business Finland's success in implementing its new programmatic approach.

In addition to the above, the primary objective of this evaluation was to provide insights into the results, relevance, added value, and impacts of the three programmes. This impact study was conducted by Sweco Finland and Sweco Sweden. Business Finland extends its sincere thanks to the evaluators for their thorough and systematic work and expresses its appreciation to the steering group and all other contributors to this evaluation.

Helsinki, April 2025
Business Finland

EXECUTIVE SUMMARY

This evaluation targeted three of Business Finland's programs that shared an overarching sustainability focus: Smart Energy (2017–2021), Bio and Circular Finland (2019–2022), and Sustainable Manufacturing (2020–2023). The objectives of the evaluation were to provide insight in what concrete results the programs have created, how relevant they have been, how well the objectives set for the programs have been achieved, and what impacts they have had. The evaluation was based on document review, data analysis and interviews. It was made by Sweco Finland and Sweco Sweden in September-December 2024.

The evaluation findings show that the programs were in general successful in reaching the direct goals set for the funded projects. The funding enabled larger and more ambitious RDI work in different innovation and business ecosystems leading to new products and services as well as to further cooperation.

These programs were among the first to combine R&D projects with a wide range of export and invest-in services. Business Finland's services were in general positively assessed, but the evaluation also shows that R&D funding and export services worked in separate tracks in these programs and were not necessarily perceived as parts of the same programmatic entity by the participating companies.

The programs were successful in strengthening existing business and innovation ecosystems, and also in supporting the creation of new ones. Sector-coupling, combining different kinds of companies in ecosystems, was seen as one of the main added values of the Business Finland funding. Company projects made it possible to accelerate the testing and piloting of solutions directly with customers along the value chain and across different value chains.

Sustainable development was well integrated in the aims of the programs, alongside business development and growth. The key themes of the programs were targeted at building capabilities for sustainable development, and project funding was specifically targeted at companies that look for sustainable solutions. Evaluation findings highlight key drivers for sustainability, with a clear focus on environment and climate perspectives.

When it comes to the role of Business Finland in enhancing longer-term impacts on business development, growth and exports, the evaluation indicates that projects have had good results, even though a full impact evaluation would need deeper analysis at a later stage. Indications of positive longer-term impacts were found especially in business development and internationalization. The contribution on growth and in jobs is highly dependent on various market factors outside the reach of Business Finland activities. However, at company level, interviewees reported positive indications of longer-term impact, and overall Business Finland's role in supporting business development and growth was seen as instrumental.

TIIVISTELMÄ

Tämä arviointi kohdistui kolmeen Business Finlandin ohjelmaan, joilla oli yhteinen kestävyystavoite: Smart Energy (2017–2021), Bio and Circular Finland (2019–2022) sekä Smart Manufacturing (2020–2023). Arvioinnin tavoitteena oli tarjota tietoa mitä konkreettisia tuloksia ohjelmat ovat tuottaneet, kuinka relevantteja tulokset ovat olleet, kuinka hyvin ohjelmille asetetut tavoitteet on saavutettu ja mitä vaikutuksia ohjelmilla on ollut. Arviointi perustui ohjelma-asiakirjojen tarkasteluun, tiedon analysointiin ja kohdennettuihin haastatteluihin. Arvioinnin toteuttivat Sweco Suomi ja Sweco Ruotsi ajanjaksolla syyskuusta joulukuuhun vuonna 2024.

Arvioinnin tulokset osoittavat, että ohjelmat olivat yleisesti onnistuneita saavuttamaan rahoitetuille hankkeille asetetut suorat tavoitteet. Rahoitus mahdollisti suuremman ja kunnianhimoisemman TKI-työn eri innovaatio- ja liiketoimintakosysteemeissä, mikä johti uusiin tuotteisiin ja palveluihin sekä lisääntyneeseen yhteistyöhön.

Arvioidut ohjelmat olivat ensimmäisiä, jotka yhdistivät T&K-hankkeet laajaan valikoimaan vienti- ja investointipalveluja. Business Finlandin palveluja arvioitiin yleisellä tasolla myönteisesti, mutta arvioinnissa huomautetaan myös T&K-rahoituksen ja vientipalveluiden toimivan erillisinä polkuina ohjelmissa, eivätkä ohjelmiin osallistuneet yritykset välttämättä kokeneet niitä osina samaa ohjelmallista kokonaisuutta.

Ohjelmat onnistuivat vahvistamaan olemassa olevia liiketoiminta- ja innovaatioekosysteemejä sekä tukemaan uusien ekosysteemien luomista. Sektoreiden yhdistäminen ja erilaisten yritysten yhdistäminen ekosysteemeihin nähtiin yhtenä Business Finlandin rahoituksen tuottamista tärkeimmistä lisäarvoista. Yrityshankkeet mahdollistivat ratkaisujen testaamisen ja pilottivaiheiden vauhdittamisen yhteistyössä suoraan asiakkaiden kanssa arvoketjun eri osissa sekä eri arvoketjujen välillä.

Kestävä kehitys oli hyvin integroitu ohjelmien tavoitteisiin, yhdessä liiketoiminnan ja kilpailukyvyn kehittämisen kanssa. Ohjelmien keskeiset teemat keskittyivät kestävän kehityksen kyvykkyyksien rakentamiseen, ja rahoitusta kohdennettiin erityisesti yrityksille, jotka etsivät kestäviä ratkaisuja. Arvioinnin tuloksissa korostuvat kestävyydelle tärkeät ajurit, joiden keskiössä ovat ympäristö- ja ilmastonäkökulmat.

Perusteellinen vaikuttavuuden arviointi vaatisi syvempää analyysiä myöhemmässä vaiheessa, mutta Business Finlandin vaikuttavuudesta liiketoiminnan kehittämisen, kasvun ja viennin edistäjänä löytyy viitteitä esim. hankkeiden hyvissä tuloksissa. Positiivisia pitkäaikaisia vaikutuksia oli nähtävissä erityisesti liiketoiminnan kehittämisessä ja kansainvälistymisessä. Kasvuun ja työpaikkoihin liittyvät vaikutukset riippuvat voimakkaasti erilaisista markkinatekijöistä, joihin Business Finlandin toiminnalla on vähäisempiä vaikuttamismahdollisuuksia. Yritystason haastattelut antavat kuitenkin myönteisiä indikaatioita pitkäaikaisvaikutuksista, ja yleisesti Business Finlandin rooli liiketoiminnan kehittämisen ja kasvun tukemisessa nähtiin keskeisenä.

1 BACKGROUND AND OBJECTIVES

1.1 BACKGROUND OF THE EVALUATION

This evaluation targets three of Business Finland's programs that share an overarching sustainability focus: Smart Energy (2017–2021), Bio and Circular Finland (2019–2022) and Sustainable Manufacturing (2020–2023). These programs provide an especially interesting evaluation object, as they were implemented as the first ones under the new Business Finland organisation. As of January 2018, the former organisations of the Finnish innovation funding agency Tekes and the Finnish export promotion organisation Finpro were fused into Business Finland, and the innovation program activities combined different kinds of innovation funding services with financial and non-financial export promotion services, invest-in services, and a wide range of market and business advisory services provided by Business Finland's global network. The three sustainability programs presented in this report demonstrate how Business Finland has succeeded in implementing this new kind of programmatic concepts.

During the cause of the programs, Business Finland has undergone a number of other developments as well, with the emerging of new business and ecosystem development instruments, in particular the Leading Company instrument and co-innovation funding. These instruments are analysed more in depth in separate evaluations commissioned by Business Finland in 2024, but the present also provides some insight in the role of thematic programs in this new operational environment.

The evaluation aims at providing insight in the added value of Business Finland's activities in meeting global sustainability challenges, and enhancing the green transition, a biobased circular economy, and a resource-efficient, automated and data-driven economy. The same themes are present also in other Business Finland activities launched during these years, and a lot of synergies can be identified between different programs.

The three evaluated programs have had their full life cycle under Business Finland's operations and been concluded by the time of this final evaluation, although some activities funded under the program umbrellas (such as some of the Leading company networks or activities funded by investment support of the European Recovery and Resilience Facility RRF) are still ongoing.

1.2 OBJECTIVES AND EVALUATION QUESTIONS

Business Finland programs generally aim at encouraging businesses to take advantage of market transitions and enhancing their understanding of future business trends and themes. The objectives of this evaluation were to create detailed information for each of the programs on what concrete results the programs have created, how relevant they have been, how well the objectives set for the programs have been achieved, and what impacts they have had.

This report provides an overview of the programs in Chapter 2, followed by the evaluation findings of each program: Bio and Circular Finland in Chapter 3, Sustainable Manufacturing in Chapter 4 and Smart Energy in Chapter 5. The report is concluded with a joint summary of the impacts and added value of the three programs (Chapter 6). Table 1 lists the specific evaluation questions and the chapters where they are addressed.

1.3 APPROACH AND METHODS

The evaluation was conducted by a team of evaluators from Sweco Finland and Sweco Sweden. It was conducted during September – December 2024.

TABLE 1. EVALUATION QUESTIONS AND RELATED CHAPTERS IN THE REPORT

EVALUATION QUESTION	REPORT CHAPTERS
What has been the main added value from the programs?	Chapter 6
What has been the contribution on business development, exports, jobs and internationalization of the participating companies?	Chapters 3.4, 4.4 and 5.4
Regarding implementation and services of the programs, what has worked well and what has not, with reasons explained. What have been the mechanisms of impact of successful services?	Chapters 3.3, 4.3 and 5.3
What have been the critical bottlenecks or obstacles, if any?	Chapters 3.4, 4.4 and 5.4
How does the perspective of sustainable development manifest in the programs and in the results and impacts achieved?	Chapters 3.5, 4.5 and 5.5
What can be said about the advantages/disadvantages, results and impacts of executing programs that have a wide scope vs. narrow scope (e.g. regarding the scope of thematic focus or scale of services).	Chapters 3.6, 4.6 and 5.6
What implications and practical recommendations can be made regarding the extent and ways of stakeholder collaboration, to increase resource-efficiency and handprint of Business Finland?	Chapters 3.2, 4.2 and 5.2, Chapter 6
For which types of goals do intensive stakeholder collaboration and partnerships particularly enhance impact, and how do they achieve this?	Chapters 3.2, 4.2 and 5.2

In parallel with this evaluation, Business Finland commissioned a number of other evaluations on partly similar topics. These concerned the Evaluation of Business Finland's activities under the Recovery and Resilience Facility (RRF) (conducted by Sweco Finland and Sweco Sweden), the evaluation of the Green Growth and Food From Finland programs (conducted by VTT and MDI) and the evaluation of the Leading Company Initiative (conducted by VTT). The Green Growth and Food from Finland evaluation and the present evaluation of three sustainability programs reported to the same Steering Board appointed by Business Finland.

This evaluation focused on the activities conducted under the three programs Smart Energy (2017–2021), Sustainable Manufacturing (2020–2023), and Bio and Circular Finland (2019 - 2022) during the ordinary program periods. From time to time, the evaluation also refers to development established during the program period and under the program umbrella which has continued after the end of the program period. This includes especially activities funded by the RRF, as well as ongoing Leading Company Initiatives referred to in the program's funding overviews. Some of these projects are on-going. It should be noted that the project funding data provided for the evaluation covered also the projects that have continued after the programs ended and this data is used unless otherwise mentioned.

The evaluation was based on the following information sources:

- Final reports of the programs as well as other program documents and presentations
- Funding data of the projects, lists of participants, information on the organisations and public project summaries (provided by Business Finland)
- Some program data extracted from Business Finland's new CRM. This information is not comparable across programs and should be interpreted with some cautiousness, since the new system did not cover the whole program periods and some variations were identified in how the CRM had been used in the programs.
- Scoping interviews (6 in total) were conducted with Business Finland key staff (former Heads of the evaluated programs and other key staff managing programmatic activities).
- Participant interviews: A total of 26 survey-supported structured interviews were conducted with companies and research organisations that had received funding from the program, and companies that had participated actively in other program activities e.g., export services.

2 THE EVALUATED BUSINESS FINLAND PROGRAMS

2.1 GENERAL DESCRIPTION OF THE PROGRAMS

2.1.1 BIO AND CIRCULAR FINLAND

Bio and Circular Finland[1] aimed to foster competitive bio- and circular economy solutions and ecosystems that address global environmental challenges and have market potential. The program focused on boosting exports of Finnish bio- and circular economy solutions, with special emphasis on the plastic, textile, and packaging industries. The program also supported different circular economy innovations in wood based and construction sectors.

The program was carried out between years 2019 to 2022. In total the program has funded 458 projects with around 285 M€ funding awarded by BF[2]. The total volume of the program funding in Bio and Circular Finland was 641 M€, of which 285 M€ from BF and 356 M€ self-funding from participants. Self-funding from companies was

1 Business Finland, n.d.

2 Based on the project funding data provided by BF for the evaluation. Throughout the report, figures are based on the project funding data provided for this evaluation, unless otherwise mentioned. This data includes also the program projects that got funding from RRF and which are partly on-going. Also, unless otherwise mentioned the project funding data is based on the award decisions made by BF (not on actual payments).

320 M€ and from research organisations 36 M€. The total volume of the Bio and Circular Finland program also included a notable amount of funding from RRF during years 2021–2022 for projects which mostly continue until 2025. The total amount of awarded BF's funding for the Bio and Circular Finland program from the RRF instrument has been 91 M€.

2.1.2 SMART ENERGY

Smart Energy Finland was carried out between years 2017–2021 and as well as Bio and Circular Finland, it aimed to support internationalisation and export activities. The Smart Energy program stimulated and financed different kinds of energy-related ecosystems and testbeds, both in Finland and internationally. The key focus areas in this program included waste-to-value, bioenergy, biofuels, smart grids, district energy, hydrogen, power-to-X, and batteries, with a significant emphasis on digitalization as a core aspect[3].

The program funded in total 287 projects, and the total BF funding was around 152 M€. The total volume of the program funding in Smart Energy was 469 M€, of which 152 M€ from BF and 317 M€ self-funding from participants. Self-funding from companies was 286 M€ and from research organisations 31 M€.

2.1.3 SUSTAINABLE MANUFACTURING

Sustainable Manufacturing Finland started in year 2020 and lasted until the end of 2023. The program was targeted at manufacturing ecosystems, and it aimed to renew business models and enhance productivity, while also actively pursuing solutions to tackle the challenges posed by climate change. Special emphasis was put on the machine tool industries, (opto) electronics and photonics, as well as companies involved in industrial digital transformation[4].

The program supported in total 231 projects with a total of around 172 M€ of BF funding. Total volume of the program funding in Sustainable Manufacturing was 443 M€, of which 173 M€ from BF and 270 M€ self-funding from participants. Self-funding from companies was 253 M€ and from research organisations 17 M€.

2.2 FACTS AND FIGURES

All three programs were open for research organisations and companies of all sizes. Table 2 presents an overview of the programs, summarising the total number of projects, BF funding for companies as well as BF funding for public research for each program. Total volume of funding for all three programs together was 1 552 M€, of which 609 M€ BF funding and 943 M€ self-funding from participants. Of

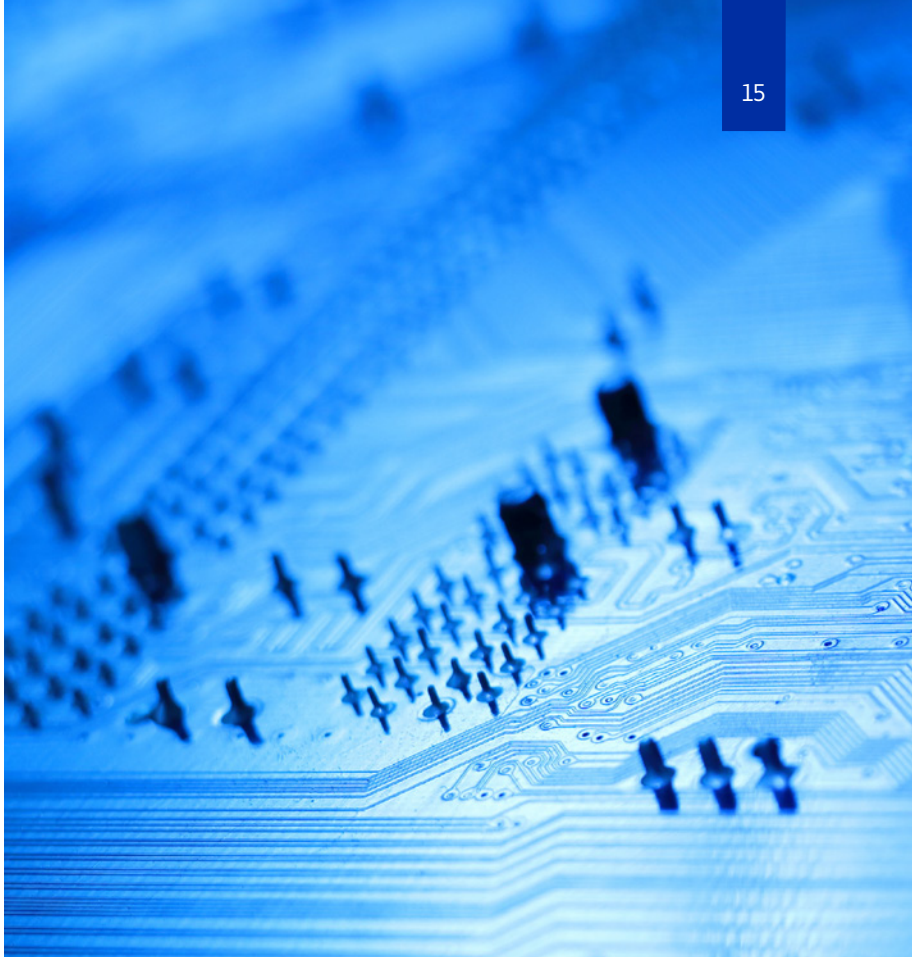
3 Business Finland, n.d.
4 Business Finland, n.d.

TABLE 2. OVERVIEW OF THE PROGRAMS

BF PROGRAM	TOTAL NUMBER OF PROJECTS	BF FUNDING FOR COMPANIES: GRANTS €	BF FUNDING FOR COMPANIES: LOANS €	BF FUNDING FOR PUBLIC RESEARCH €
Bio and Circular Finland	458	184 789 900	29 297 760	71 230 491
Smart Energy	287	77 058 320	25 394 100	49 565 322
Sustainable Manufacturing	231	128 115 814	5 134 780	39 271 050

TABLE 3. OVERVIEW OF THE BF FUNDING FOR THE DIFFERENT TYPES OF ORGANISATIONS IN THE PROGRAM. DATA IS BASED ON THE PROJECT FUNDING INFORMATION PROVIDED FOR THE EVALUATION.

BF FUNDING (AWARDED)			
SIZE OF THE ORGANISATION	BIO AND CIRCULAR FINLAND	SMART ENERGY	SUSTAINABLE MANUFACTURING
Micro	35 836 116 €	16 946 898 €	4 649 705 €
Small	37 752 125 €	9 832 800 €	7 460 574 €
Middle	16 343 861 €	5 464 124 €	18 947 950 €
Big companies	119 480 114 €	70 035 398 €	102 192 365 €
Research organisations	70 707 230 €	49 303 322 €	39 271 050 €
Not defined	5 198 705 €	173 200 €	- €
Total	285 318 151 €	151 755 742 €	172 521 644 €



943 M€, 858 M€ came from companies and 85 M€ from research organisations. Bio and Circular was considerably bigger than the other two programs, both with a view to the amount of projects and total funding awarded by BF.

The sizes of the organisations receiving BF funding varied from micro companies to big companies. Different types of organisations and organisational sizes were represented in each program, but the emphasis on BF funding was in big companies. Table 3 presents the overview of the funding in different types of organisations per programs, including also research organisations.

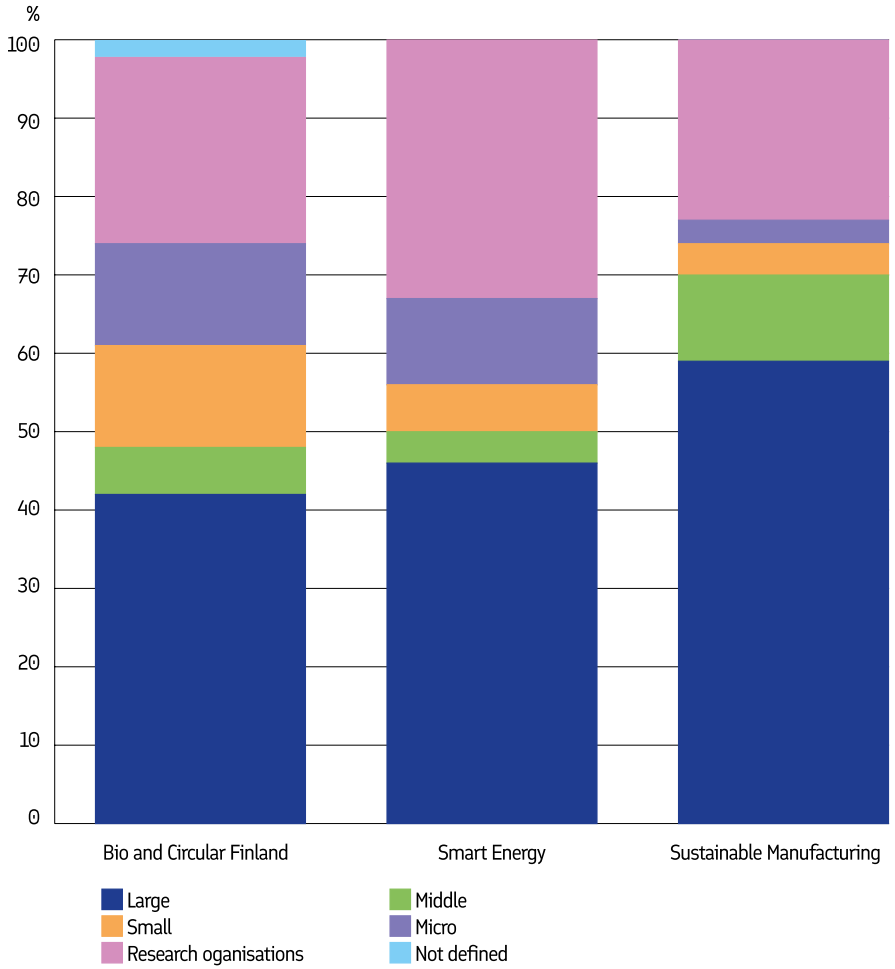


FIGURE 1. SHARE OF BF FUNDING TO DIFFERENT TYPES OF ORGANISATIONS.

Figure 1 visualises the share of BF funding directed to different organisations. Each column represents one program, and the percentage share of each organisation type is marked in the figure. The figure illustrates that the majority of BF funding was directed to the larger companies. The second largest type of organisations receiving BF funding was research organisations.

Table 4 presents the BF funding to different sectors, with the five largest sectors highlighted for each program. In Bio and Circular Finland, the largest sectors receiving BF funding were manufacture of chemicals and chemical products, with a significant amount of BF funding compared to other largest sectors. In Smart Energy, the difference between sectors is slightly smaller, but manufacture of electrical equipment stands out with the most BF funding amongst sectors. In Sustainable Manufacturing, the manufacture of machinery and equipment was by far the largest industry sector receiving BF funding.

These basic facts and figures form some understanding of the structure of the programs, which are more in depth analysed in the following chapters 3–5.

TABLE 4. BF FUNDING AWARDED TO DIFFERENT SECTORS (5 BIGGEST ONES BY SECTOR HIGHLIGHTED WITH GREEN TO EACH PROGRAM)

INDUSTRY SECTOR (TOL CLASS OF THE COMPANY)	BIO AND CIRCULAR FINLAND	SMART ENERGY	SUSTAINABLE MANUFACTURING	TOTAL
28 Manufacture of machinery and equipment n.e.c.	10 468 884 €	6 924 700 €	64 530 340 €	81 923 924 €
20 Manufacture of chemicals and chemical products	53 106 209 €	10 491 000 €	73 500 €	63 670 709 €
27 Manufacture of electrical equipment	572 400 €	27 878 300 €	1 662 644 €	30 113 344 €
71 Architectural and engineering activities; technical testing and analysis	2 322 580 €	9 374 050 €	16 822 905 €	28 519 535 €
30 Manufacture of other transport equipment	- €	266 900 €	21 309 000 €	21 575 900 €
38 Waste collection, treatment and disposal activities; materials recovery	21 436 241 €	- €	- €	21 436 241 €
17 Manufacture of paper and paper products	17 733 749 €	- €	112 500 €	17 846 249 €
25 Manufacture of fabricated metal products, except machinery and equipment	9 597 835 €	747 800 €	6 541 120 €	16 886 755 €
35 Electricity, gas, steam and air conditioning supply	10 030 400 €	6 729 822 €	- €	16 760 222 €
26 Manufacture of computer, electronic and optical products	5 911 500 €	5 744 698 €	3 103 375 €	14 759 573 €
46 Wholesale trade, except of motor vehicles and motorcycles	7 999 151 €	4 922 300 €	1 144 000 €	14 065 451 €
10 Manufacture of food products	11 944 850 €	50 000 €	- €	11 994 850 €
62 Computer programming, consultancy and related activities	1 745 500 €	4 594 500 €	3 567 310 €	9 907 310 €
22 Manufacture of rubber and plastic products	9 073 320 €	- €	125 000 €	9 198 320 €
24 Manufacture of basic metals	4 798 968 €	1 288 000 €	1 897 000 €	7 983 968 €
23 Manufacture of other non-metallic mineral products	4 138 725 €	406 000 €	1 502 000 €	6 046 725 €
29 Manufacture of motor vehicles, trailers and semi-trailers	- €	947 100 €	5 043 750 €	5 990 850 €

3 EVALUATION OF THE BIO AND CIRCULAR FINLAND PROGRAM

3.1 PROGRAM THEMES AND PARTICIPANTS

The Bio and Circular Finland program of Business Finland (BF) run between 2019–2022 and activities were to some parts continued after that with RRF funding. Specifically, textile related export promotion services were continued as part of the RRF decarbonizing industries activities and plastic related circular economy theme in Japan continued as part of IBI activities. In addition to RDI funding for nearly 500 projects, Bio and Circular Finland actively organised export promotion, marketing and information dissemination activities. It is estimated that these attracted participation of 6500+ people[5].

The total volume of the program funding in Bio and Circular Finland was 641 M€, of which 285 M€ from BF and 356 M€ self-funding from participants. This total volume included also the European Commission's Recovery and Resilience Facility (RRF) funding which was introduced in 2021. BF organised the RRF funding through multiple funding services and targeted calls. RRF funding was tar-

5 Business Finland (2023), Bio and Circular Finland final report.

geted at advancing green transition and digitalisation and thus fit well with the Bio and Circular Finland objectives. A total of 54 RRF-funded projects starting late 2021 (in total 91 M€) were allocated to the program. A major part of these (57 M€ and 27 projects) were allocated to new circular economy investments' support, creating a bridge from R&D to investments. Out of these RRF Bio and Circular Finland projects 43 are still on-going and continue until end of 2025.

At the time of planning the program, bio and circular economy had high strategic relevance for Finland and for BF. The main idea was to support the transition from fossils to bio-based and circular raw materials. Selected focus areas for the program were textiles, packaging (especially food packaging), the value chain from forest to the sea, and waste to value. The program focused on export campaigns, innovation activation (emphasis on ecosystems), including investment aid funding and support for Invest in Finland (IIF). At the starting point in 2018 the program set the following goals:

- **New Bio-Based Products and Circular Solutions:** New innovations from world-class research competences; innovation partnerships with 2 countries; EU & EIB funding; new business models; investments in start-ups; scalable export to selected markets (5 new markets)
- **New Circular Economy Ecosystems**: Ecosystems created, and first solutions demonstrated (Circular Manufacturing, Carbon and Nutrient Circulation, Construction and Real Estate)
- **Circular Economy Data Platforms:** 2–3 material circulation platforms demonstrated
- **Consumer Business:** New co-creation-based business models (also in BF funded projects); test environments; new start-ups; new brands; new international customers
- **Communications:** Finnish solutions to global circular challenges are present in the international media; competence scouting to Finnish reference cases

One of the key driving forces of the program were the anticipated regulative changes and tighter EU regulation in many of the program focus areas which shape the market demand. The uncertainties related to these developments partly justified the relatively wide scope for the program.

Participating companies in the program that received funding represented mostly chemical and chemical products; waste collection, treatment and disposal; forest and paper; electricity, gas, steam and air conditioning supply; and food industry sectors (see Table 4 in Chapter 2). Typical for these sectors is the dominant role of large companies and also strong home markets for example in waste and food sectors. 42 % of funding allocation was targeted to big companies.

Next to large and established SME companies there was a notable amount of start-ups receiving funding support. The evaluation estimated that there were 27 companies receiving funding from the program that can be classified to be start-ups with an ambitious growth strategy (see details in Chapter 3.4).

3.2 STAKEHOLDER COLLABORATION AND PARTNERSHIPS

Over the time of the program, BF has introduced new instruments supporting industry-research collaboration and partnerships. Especially the Leading Company instrument and co-innovation project funding are visible in the program. Bio and Circular Finland targeted to strengthening the existing ecosystems and aimed to build new ones. The program built a clear roadmap for target ecosystems in the beginning of the program period.

Based on the interviews and final report, the program has been very successful in strengthening the ecosystems, and also in supporting the creation of new ones. Different ecosystems are now often the main "homebase" for companies. The most relevant Leading Company programs linked to the program were[6]: 1. Neste (solutions for transportation and chemicals), 2. Fortum and MetsäGroup, ExpandFibre (bio-based fibre products for consumers), 3. Valmet (waste and emissions to valuable resources), 4. Borealis Polymers (sustainable plastics industry transformation). Based on the project data it was estimated the program supported around 40 business and research co-innovation groups of projects. Large number of these focused on material research for finding new sustainable solutions (e.g. to find biobased material solutions). Some examples of the larger relevant co-innovation funded ecosystems in the program with a clear continuation are described in the Information Box 1.

6 Listed in Business Finland (2023) (Final report of Bio and Circular Finland) and validated also in the interviews.

INFORMATION BOX 1.

Examples of ecosystems funded by Bio and Circular Finland

Textiles recycling ecosystem development had started already before the Bio and Circular Finland with Tekes funded Telaketju project for finding new users and applications for various textile fractions. The project already involved a number of research partners and more than ten companies. The work continued in Bio and Circular Finland with Telaketju 2 project, which focused on circular economy business models related to textiles. The work further continued with Telavalue funded by RRF. Over the years, the public research projects have been carried out by VTT, LAB University of Applied Sciences and Turku University of Applied Sciences and has involved tens of companies.

BATCircle battery metals consortium aims at improving the manufacturing processes of mining industry, metals industry and battery chemicals, and to increase the recycling of lithium-ion batteries. The first BATCircle project was part of the Bio and Circular Finland, and the follow-up consortium project continues (within Batteries from Finland program). The ecosystem comprises four universities (Aalto University, University of Oulu, University of Eastern Finland, LUT University), two research centres (GTK, VTT), and 15 companies.

Fold consortium aims to create a completely new portfolio of industrially foldable products that increase export volume and open new business opportunities for Finnish companies. The Novel folding technology will be a radical innovation in the paper and packaging industry, as well as in other industry areas, enabling industrial scale production of never-before novel structures for a wide variety of applications. Fold ecosystem has proceeded in two phases with promising results. VTT and Aalto University are the research partners, and the consortium involves 6 companies.

Five Bio and Circular Finland ecosystems received funding from the RRF instrument after 2022:

- Hiper - High Performance Cellulose-Based Composites, coordination by VTT
- ROBA - Robust Algae Systems, VTT
- Synjet - Alternative routes from syngas to renewable jet fuels and chemical intermediates, VTT, JY, ÅA,
- Telavalue - Value chains for sustainable production, use and cycles of Textiles, VTT, LAB University of Applied Science
- UrbanMill - New urban recycling concept to maximize the utilisation of plastic waste, VTT

VTT has had a key role as a coordinator and lead partner in most of the funded ecosystems. In total VTT was granted 30 M€ BF funding and 61 projects from the program. Other key research partners often mentioned in the company interviews were Aalto University, Lappeenranta University of Technology (LUT), University of Tampere, and University of Oulu.

Based on the interviews, the participants have been very satisfied with the collaboration and partnerships. The co-innovation model has worked well with clear synergies and coordination among projects but also enabling parallel company projects. The parallel company projects made it possible for example testing results directly with customers and along the value chain. Solving circular economy challenges requires cross-disciplinary research and testing across different value chains. It was often mentioned in the interviews that the projects have helped to build up new networks. This also came up in the interviews with larger companies – the public funding has enabled extension of the RDI work to novel areas, helping to create also new networks when the right knowledge or customers for new applications are sought for.

3.3 BUSINESS FINLAND AND PROGRAM SERVICES

Based on the interviews, the program was not perceived by the users as a program with a clear identity or added value, as such. This is partly due to its wide scope but is most probably also reflecting the emergence of the new instruments targeted at supporting ecosystems, many of which are working as programs on their own (e.g., Leading Company programs). These new instruments have been well received and provide a natural network and contact point for companies working with the same concrete challenges. The concept of BF programs and services remains somewhat unclear to users. As one interviewee stated, “Aren’t the programs just for BF’s internal planning purposes?”. Compared to the Tekes programs in the history, the role of the programs has diminished. Another question is whether the role of programs is even relevant to maintain, if the

main impact is created through concrete services addressing real company needs.

Generally, the spontaneous reaction of interviewees to BF's services was positive: the BF's dedicated company contact points were experienced to be helpful, easy to communicate with, and proactive. Secondly, interviewees often referred to other RDI projects that have been proceeding the work or are planned in the future. One should note that the interviews were mainly done with companies that had received RDI funding and with persons leading RDI, so the answers might reflect that these people do not usually have responsibility for marketing, sales, and export activities, and thus not so much experience of these BF services. Figure 3 in Chapter 6 gives a summary of findings in the interview survey on the questions of what BF services had been used by the respondents.

The program did, however, invest heavily in different services focused on export, marketing and information dissemination. The customer satisfaction for these was at a high level. Based on data extract from BF's CRM and the final report, the key activities and main observations are the following:

- The program directed export activities particularly for the textile and packaging industries. Market targeting was re-directed a few times during the program. The target market of Russia was for example changed to Poland following Russia's war of aggression on Ukraine. Overall, export activities were primarily targeted to Germany, Sweden, the Netherlands, Japan and the USA. Especially the export activities to Japan with packaging industries got a lot of attention.
- Based on the CRM data, the program organised eight business delegation visits, most of them to Japan, and organised as online events due to the COVID -19 pandemic. A few business delegations and match making events were organised to the USA. In addition to these, there were numerous business meetings organised and during the program a "speed dating" matchmaking concept was developed for supporting direct contacting during pandemia time.
- A majority of the program activities were webinars (67% of the total program activities based on the final report, 14 based on CRM statistics). Webinars were based on the content produced in separate studies and the overviews of the Finnish offering produced by BF.

In the interviews, these services did come up after more detailed discussions. There had been participation in business delegations resulting in new contacts and potential international partners. Most often the role of the global network and BF contact points in other countries were mentioned as the main service adding value.

3.4 RESULTS AND IMPACTS ON BUSINESS DEVELOPMENT, GROWTH, AND EXPORT

Bio and Circular Finland was one of the biggest BF / Tekes programs ever with BF funding of little less than 280 M€ and the total volume of projects around 640 M€. The program had a wide scope, and the results span a wide range of industry sectors and types of projects. A notable part of the funding was investment support used for piloting and testing plants (from the separate RRF funding instrument). The different results and impact categories identified are elaborated in the following chapters.

CREATING NEW SOLUTIONS

Based on the program's final report and the interviews, the program was generally successful in reaching the direct goals set for the funded projects. The funding enabled larger and more ambitious RDI work in different innovation and business ecosystems leading to new products and services as well as to follow-up RDI. For SMEs the support was crucial for developing new solutions.

The bio and circular economy challenges that the program set out to solve and the results from the projects included very practical advances with recycling, waste management, and development of new materials. Based on the interviews and project summaries, a typical project focused on testing and studying different materials or production technologies in varying contexts. In the interviews a typical summary of results was that some of the alternatives tested and worked with in the project had led to concrete useful results in terms of new products or production technologies, while others had led to lessons learned on why some alternatives do not work. Based on the interviews, concrete results with piloting and production technologies were mentioned more often than in the other evaluated programs (see the overview summary of the interview survey of the results from the projects in Figure 4 in Chapter 6). This is partly due to the role of the investment support provided by the RRF instrument via the program.

The public project summaries highlight the following five areas to be the most often appearing in direct result categories[7]:

- **Recyclability and Circular Economy:** The importance of recycling and creating a circular economy was emphasized in various projects, such as the SYMMET consortium, which aims to improve material and energy efficiency in metal production, and the ECOtronics consortium, which focuses on developing recyclable and compostable materials in the electronics industry.
- **Bioplastics and Bio-based Materials:** The use of bioplastics and bio-based alternatives is a recurring theme. For instance, the project addressing electron-

7 The list is created with SwecoGPT based on the public summaries.

ics waste proposes replacing conventional materials with bioplastics like PLA and PHB. Similarly, the BioProt project focuses on developing bio-based nonwoven materials for healthcare applications, showcasing a shift towards sustainable materials in different industries.

- **Waste Utilization:** Several projects, including the concrete recycling initiative and the KiMuRa project, emphasize the need to utilize waste materials effectively. The concrete project aims to recycle demolished concrete for new building materials, while the KiMuRa project focuses on creating a recycling model for composite plastic materials, indicating a broader trend towards waste valorization.
- **Sustainable Construction:** The focus on sustainable construction practices is evident in projects like EcoUps' ECOGREEN initiative, which aims to recycle demolition waste for building materials, and the Mimepro Matnur project, which develops green construction products from geopolymers and other materials. Both projects highlight the importance of reducing environmental impact in the construction sector.
- **Digital Technology and Data Handling**: The integration of digital technology and data handling is mentioned in a project, which looks into consumer acceptance and data handling for reusable packaging, and the BioProt project, which applies digital technology to monitor product performance.

PROCEEDING WITH INVESTMENTS TOWARDS GROWTH AND JOBS

Main industry sectors of Bio and Circular Finland program are very investment incentive. Whether investing in practical circular solutions in Finland or in scaling-up Finnish innovations abroad, large investments are needed. The Confederation of Finnish Industries (EK) maintains a database of green investments and in November 2023 it listed investment projects at different phases with a worth of 15 billion € in the Bio and Circular Finland specific areas[8] and even more in the larger Bioproducts and Bioenergy areas.

The potential role of green investments for the economy and society is big. A recent study ordered by EK together with other industrial associations examined the impacts of investments on GDP, taxes and jobs[9]. Analysis was done for five main areas of green investments, including bioproducts and bioenergy, which include many of the Bio and Circular Finland sectors. These investment projects are often more mature than in other sectors and the estimated expected investment volume in October 2024 amounted to 25 billion €. This is estimated to correspond with work of 82 000 man years and 2,8 billion € taxes[10].

Based on the EK database, the total investment volume of circular economy, textiles, and plant-based food products is 1 billion € (circular economy being the biggest with an estimate of 893 M€). A majority of the companies planning and implementing these investments have been or are (as part of RRF) Bio and Circular Finland customers. In the textile fibres and plant-based food sector all companies having their projects listed in the database have been Bio and Circular Finland customers and their investment projects have received also BF support.

The progress of the investments depends on many factors and there are a lot of uncertainties. Packaging, plastics, and textile innovations that have received support from the program have taken many good steps ahead to scale-up from RDI to investing in new plants and production lines. Examples of these mentioned in the program final report were, e.g., Infinited Fiber Company, Wipak, Fortum Recycling, CH-Bioforce, SSAB & Saint Gobain. Both larger and smaller companies appreciated the BF's support also for their investments and hoped that this type of instrument would be used also in the future by the BF. Especially useful is to have support for the first steps to move from laboratories to first industrial scale piloting. The former Climate Fund had an important role as an investor for many of the cases. It will be seen how Tesi now takes over the role in supporting the investments in Bio and Circular Finland sectors.

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8 Categories used: Biojalostamot, Fossiilisten korvaaminen, Mineraalit, Biotuotteet, Kiertotalous, Tekstiilit, Kasvipohjaiset ruokatuotteet. **Green investments in Finland - Elinkeinoelämän keskusliitto**

9 Gaia Consulting (Sweco Finland) (2024) **Loppuraportti_Vihrean-siirtyman-investointien-vaikutusten-arviointi-1.pdf**

10 The report has more profound and detailed analysis of the used estimates, maximum values, and break downs by years. The role of investment for the society is also summarized in more detail in the Mid-Term evaluation of BF's RRF funding finalized by the end of year 2024.

START-UPS AND FUTURE GROWTH OPPORTUNITIES

The identification of the start-up companies was done based on filtering the companies that were less than 5 years old at the time of start of the program and micro or small in size. Subsidiaries of large multinationals and not-growth seeking small companies were excluded. Each one was further assessed based on the public financial information and their web pages as well as with interviews. In total there were 27 growth-seeking start-ups. In the interviews, no evidence was brought up on new start-ups that would have resulted from Bio and Circular Finland projects.

The reviewed companies are thus now in 2024 max 10 years old, and the progress looks very promising. From 27 there are only 3 that have ceased (bankruptcy or otherwise no relevant operations anymore). In the interviews it was highlighted that the BF support had been critical for the companies. It was also noted that the funding had been especially important for overcoming the difficult pandemia years that coincided with the program. Some companies especially mentioned the use of Young Innovative Companies support which had helped in the early phases or to preserve continuation. The reviewed companies also used more export support services and BF's global advisory services than other companies.

Most of the start-ups were research based and many had their roots in research done at VTT. Most of them are at the moment in the RDI phase and will require further

RDI investments for the future. Most of the companies are also in business areas that will require future production and in very investment incentive sectors. The role of BF in helping to find potential investors and partners especially for international growth was mentioned and the help that had been received was appreciated. There are also examples of companies that are clearly on the growth path such as Infinited Fiber Company Oy and Spinnova Oy.

EXPORT GROWTH

Concrete numbers on increased volumes of export are not available but in the long run the expected export from the projects was estimated to reach up to 6 billion € based on the project applications[11]. Interviews supported the conclusion of the final report that the biggest success has been with the global large companies which have recognized Finnish know-how through the program and are planning cooperation with Finland. The biggest challenges have been encountered in scaling the solutions of the small companies to international markets but the same companies experiencing these challenges also appreciated the support provided by BF the most. Based on the interviews, SMEs used the BF's export support services broadly. For example, the global BF advisory network was seen to provide the right help for concrete needs that companies had in finding the right partners, opening the doors to customers or getting help in recruiting people from abroad.

Some highlights of export results based on the Bio and Circular Finland final report include:

- In the packaging sector, the largest export impact was seen in Germany and in Sweden. In both market areas business contacts have been opened up to big brands. The international companies became more aware and interested in Finnish sustainable packaging solutions.
- Also in the textile sector, the export focus was on Germany and Sweden. Finnish textile companies gained more international credibility and succeeded in creating significant contacts with international buyers.
- In Japan, a great number of Japanese companies were matched with Finnish companies, about 50 business matchings altogether.
- In Japan, the program contributed to creating an ecosystem where Finnish companies jointly offer systemic solutions for Japanese plastics' challenges.
- In USA, the collaboration between the states of Michigan, Maine and Washington started successfully during the program. The final report highlights the MoU between Finland and Maine and Michigan as one of the most important milestones in international collaboration. The emphasis was on innovation collaboration. Finnish offering especially related to wood-based products gained a lot of interest.

11 Bio and Circular Finland Final Report

- Finland was recognized as a pioneering circular economy country in Africa (Rwanda, Ghana and Nigeria) and as a potential partner for European countries. European collaboration opened new funding possibilities from European Union's funding.
- In Poland, the waste to value operations attracted new contacts in regional governments and in larger companies, and areas for potential collaboration were selected.
- Bio and Circular Finland and Invest in Finland (IIF) collaborated with the Nordic Circular Hotspot in organising Nordic Circular Summits in 2021 and in 2022. Bio and Circular Finland joined World Circular Economy Forum in different locations globally presenting Finnish know-how and solutions in circularity.

KEY RISKS FOR FUTURE GROWTH

The following key risks and obstacles for future growth came up in the interviews.

- **Loss of Competitive Edge**: Finland has had leading position in some areas like in textile recycling and is at the good level, but these positions are easily lost when the circular economy markets evolve and if there is a lack of investment willingness.
- **Investment Dependency on Volume**: Recycling and more broadly circular economy investment decisions are contingent on securing sufficient volumes of waste (like plastics) and materials, which may not be available.
- **Market Responsiveness:** Changes in the market, particularly due to regulative changes and geopolitical events like the war on Ukraine, can impact demand and operations.
- **High Technology Risks:** There is often uncertainty regarding the development of commercial products and machinery, particularly in the transition from pilot plants to full-scale production. Technology development and investments in RDI are needed.
- **Insufficient Infrastructure:** Existing machinery and facilities may become outdated, hindering operational efficiency and expansion. This also applies to research infrastructures like different testing environments.
- **Financial Difficulties:** Revenue generation from projects may not sufficiently offset costs and support further investments.
- **Expansion Challenges:** The need for further investments for expansion plans into other countries and in Finland.
- **Talent Acquisition:** Difficulties in building a capable team from a global talent pool may hinder project execution and innovation.

3.5 IMPACTS ON DEVELOPMENT OF CAPABILITIES IN SUSTAINABLE DEVELOPMENT CHALLENGES

The program's main target was to develop competitive bio and circular economy solutions and ecosystems that offer solutions to global environmental challenges. The program's slogan was 'saving the planet is good business'. The projects of the program focused on these targets. In the company interviews the question of the role of sustainability was almost obsolete since all the projects focused on finding some competitive edge by creating new solutions to e.g., material use and waste management, and energy efficiency.

In the interviews it was discussed that over the timeframe of the program there had been a lot of market changes affecting the future developments. In the beginning the focus of a project was perhaps on finding a technological solution, but over time it became more and more relevant to respond to the requests of evolving regulation and reflected in customer demands. A concrete example of this was the increased need to do carbon footprint and LCA analyses for new solutions.

The program was influential in taking Finnish knowhow to a forerunner position in many areas like textile recycling, but it was highlighted in the interviews that these positions are easily lost. Markets develop quickly and many other countries and areas are easily catching up. To support the future Finnish competitive position in these areas BF has chosen in 2023 the theme of 'circular transition for zero waste' as one of the future missions for Finland.

3.6 SUMMARY OF REACHING THE OBJECTIVES

The program as a whole can be assessed as very successful. The program was especially successful in advancing concrete solutions related to bioproducts, material efficiency and circularity as well as in creating and enhancing innovation ecosystems. The investment support that was provided by the RRF funding instrument was important for taking the results ahead to scale-up and industrial testing phases. Of the set targets the consumer business dimension was not reached to the extent that was hoped for. A summary of the evaluation of reaching the targets of the program is provided in Table 5.

Bio and Circular Finland was one of the largest ever BF/Tekes programs and it had a very broad scope. It was assessed that the broad scope at the time of the planning and launch of the program as well as throughout the life cycle of the program was a good choice. This is especially due to the evolving markets and regulation related to circular economy. In this case, a very narrow scope would have been a risk for achieving the aims of the program. In the

future, a similarly wide program scope for the bio and circular economy area would not be as relevant.

The wide scope with a large number of different tracks of activities requires also a lot of practical management work. The program did not succeed in creating a strong identity of its own among the participants, but this may not be an important issue, as long as the activities and funding instruments respond to the needs of the business and innovation environment.

TABLE 5. SUMMARY OF THE EVALUATION ASSESSMENT OF REACHING THE GOALS OF THE PROGRAM

GOAL IN THE BEGINNING (2018)	EVALUATION ASSESSMENT OF REACHING THE GOAL (2024)	INDICATIVE GRADE (SCALE 0 – 5)
New Bio-Based Products and Circular Solutions: New innovations from world-class research competences; innovation partnerships with 2 countries; EU & EIB funding; new business models; investments in start-ups; scalable export to selected markets (5 new markets)	Projects have resulted in concrete advances in products and production technologies including also new innovations. Companies have had follow-up EU-funding and there has been a notable amount of start-ups that have progressed well. Areas which are less prominent are the new business models and the scale-up to international markets.	Very good, 4–5
New Circular Economy Ecosystems: Ecosystems created, and first solutions demonstrated (Circular Manufacturing, Carbon and Nutrient Circulation, Construction and Real Estate)	The program supported around 40 business and research co-innovation groups of projects. Among these there were new ecosystems and also strengthening the existing ones. The work in these ecosystems has focused on practical demonstrations. Generally, the new instruments and ecosystem support got positive feedback.	Very good, 5
Circular Economy Data Platforms: 2–3 material circulation platforms demonstrated	Based on the project information and on the program final report, there was no clear evidence of these. One should note that at the time of designing the program, the idea of material circulation platforms was prominent, but has encountered many practical challenges yet unsolved. There were, however, a number of ecosystems which focused on collaboration and material circulation among sub-sectors (e.g. battery recycling).	Not fulfilled, 2
Consumer Business: New co-creation-based business models (also in BF funded projects); test environments; new start-ups; new brands; new international customers	Based on the project information and on the final report there was no clear new consumer business targeted projects, new business models or strong new brands. However, a lot of the work in the program was in B2B area where the customers are in consumer business (e.g. textiles, food) and testing with customers has been active. These also represent international customers.	Medium, 2-3
Communications: Finnish solutions to global circular challenges are present in the international media; competence scouting to Finnish reference cases	The program did a lot of communication and marketing activities. Based on the interviews, the role of the program in helping to make Finnish knowledge visible in international markets has been good. This work has helped especially SMEs.	Good, 4

4 EVALUATION OF THE SUSTAINABLE MANUFACTURING PROGRAM

4.1 PROGRAM THEMES AND PARTICIPANTS

The Sustainable Manufacturing program of Business Finland (BF) run 2020–2023 with a total volume of 443 M€, of which Business Finland funding was 173 M€ and 270 M€ matching funding from the participants [12]. In addition to innovation funding, the program supported extensive export promotion and market activities, and according to the final report (and based on BF CRM), more than on 3 300 people from 1 055 Finnish companies used services provided by the Sustainable Manufacturing program.

In 2021, the European Commission's Recovery and Resilience Facility (RRF) funding was introduced, and BF organised that funding through multiple funding services and targeted calls. Two ecosystems within the program received funding from RRF instrument. Also, Sustainable Manufacturing facilitated the establishment of five Leading Company ecosystems that are still continuing their work at the time of this evaluation.

12 Based on Business Finland Final report of Sustainable Manufacturing (2023)

The program combined efforts to battle the twin challenges of decreases in labour productivity and climate change, with the aim of preserving resilience of Finnish manufacturing industries in an era of globalisation. The main idea of the program was to ensure sustainability and growth of the manufacturing industry, as a cornerstone in Finnish economy, as the industry carries a major part of the GDP and R&D activities, employment and export.

The program focused on three key industry areas (Figure 2): 1) Machine and equipment industries, 2) Electronics and Photonics Industries and 3) Marine Industries, as well as two streams of solution providers for these industries, namely smart manufacturing solution providers and carbon handprint solution providers.

The program focused on five key services (1) National Research, Development and Innovation (RDI) Promotion, (2) International Research, Development and Innovation (RDI) Promotion, (3) New markets and business opportunities for company groups, (4) Foreign Talent to the Industry, and (5) Invest in Finland Promotion Services for Foreign Companies.

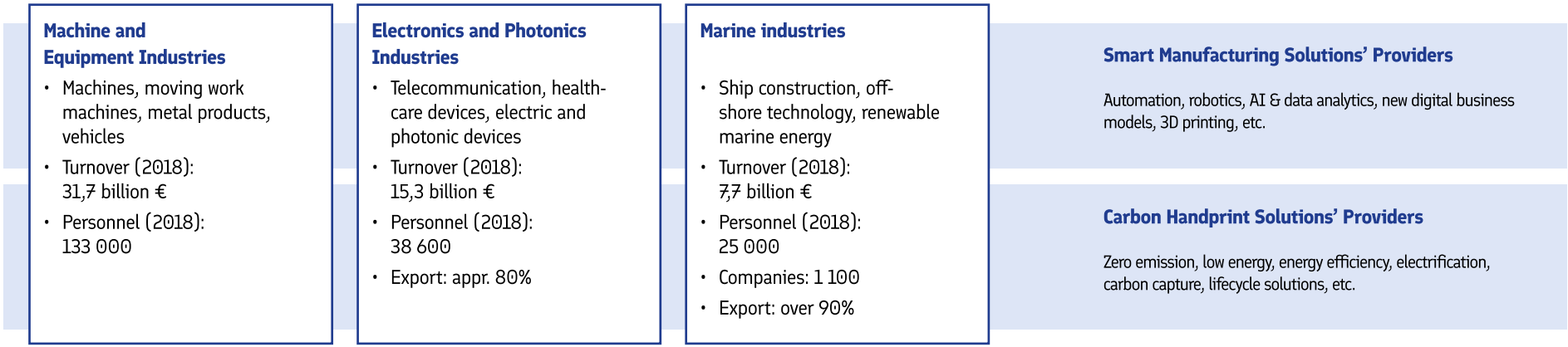


FIGURE 2. THREE KEY INDUSTRY AREAS OF SUSTAINABLE MANUFACTURING PROGRAM.

Back in 2020, the program set the following goals:

- Growth through business renewal and development of export value
- Competitive advantage from low-carbon technologies and renewed value chains
- Increased operational efficiency by reducing costs and waste
- Improved productivity through better us of digitalization and data

Quantitative targets set for the program included:

- The program should inspire and encourage Finnish companies to start working towards the goals of Twin Transition and Resilience, preferably in collaboration with other companies (150 M€ BF funds adding up to total 300 M€)
- The program should contribute to the formation of collaborative R&D projects that are to be funded by the EU by equal magnitude (150 M€ and 100 projects)
- The program should identify significant international business opportunities, helping Finnish companies to reach export growth rate of above 10 % pa. (and company engagement goal 100 companies)

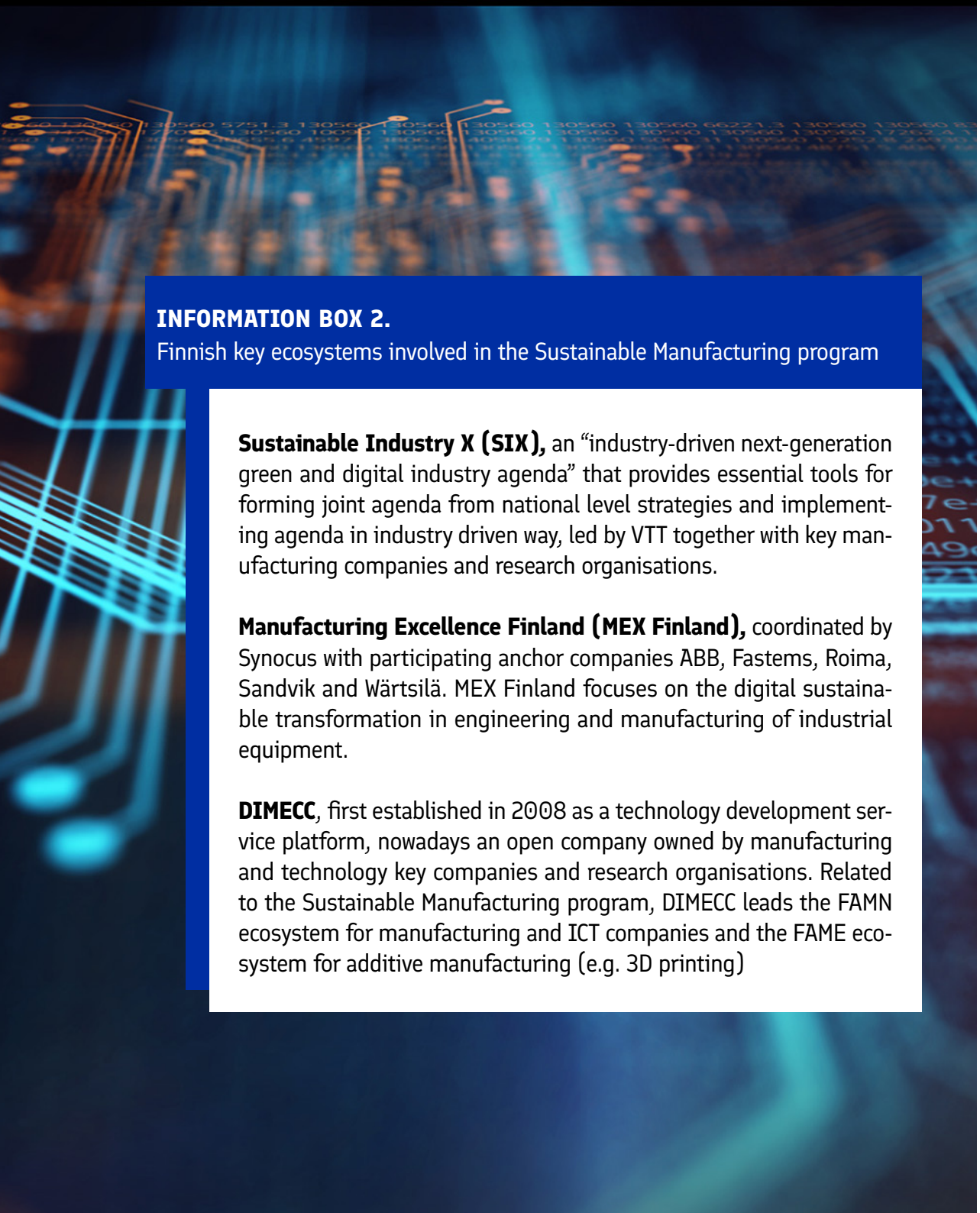
The Sustainable Manufacturing program company participants receiving funding represented mostly manufacturing of machinery and equipment and manufacturing of transport equipment, as well as engineering services (see Table 4 in Chapter 2). Almost 60% of the BF funding allocation was awarded to big companies, more than 20% to research organisations, and approximately 15% to SMEs. Among the solutions providers there were also some small and micro companies.

4.2 STAKEHOLDER COLLABORATION AND PARTNERSHIPS

Over the time of the program, BF has introduced new instruments supporting industry-research collaboration and partnerships. Especially the Leading Company instrument and Co-innovation project funding are visible in the Sustainable Manufacturing program. The program emphasized the need to encourage companies to engage with one another, and with research institutes, as this was believed to bring efficiencies and spread new ideas and good practices especially among SMEs and thus accelerate the much-needed digitalization.

Based on the interviews and final report, Sustainable Manufacturing was successful in strengthening ecosystems and also in creating new ones. Different ecosystems are now often the main “homebase” for companies.

The program had significant collaboration with three Finnish key company ecosystems that were also highlighted as key partners in different program services.



INFORMATION BOX 2.
Finnish key ecosystems involved in the Sustainable Manufacturing program

Sustainable Industry X (SIX), an "industry-driven next-generation green and digital industry agenda" that provides essential tools for forming joint agenda from national level strategies and implementing agenda in industry driven way, led by VTT together with key manufacturing companies and research organisations.

Manufacturing Excellence Finland (MEX Finland), coordinated by Synocus with participating anchor companies ABB, Fastems, Roima, Sandvik and Wärtsilä. MEX Finland focuses on the digital sustainable transformation in engineering and manufacturing of industrial equipment.

DIMECC, first established in 2008 as a technology development service platform, nowadays an open company owned by manufacturing and technology key companies and research organisations. Related to the Sustainable Manufacturing program, DIMECC leads the FAMN ecosystem for manufacturing and ICT companies and the FAME ecosystem for additive manufacturing (e.g. 3D printing)

Five Leading Company ecosystems that were still ongoing at the time of this evaluation were established under the Sustainable Manufacturing framework[13]:

1. Sandvik Shift '25 is about sustainability in mining. The goal is to develop globally scalable solutions for mining industry utilizing digitalization and electrification technologies.
2. Mayer Turku Climate-Neutral Cruise Ship (NECOLEAP) focuses on responsible technology solutions in the ship itself, shipbuilding, smart technologies, and future drivers.
3. Valmet Beyond Circularity focuses in transforming waste and emissions into valuable resources for sustainable growth and accelerating the green transition.
4. Picosun/AM Chip Zero (Challenger company ecosystem) focuses on (i) development of resource-efficient semiconductor manufacturing equipment, processes and materials, (ii) boosting circularity by linking value chains to closed resource cycles, and (iii) increasing positive environmental aspects of semiconductor components, with focus on power components and different aspects of electrification.
5. Ponsse&EPEC Forward '27 (Challenger company ecosystem) is focused on creating sustainable off-road heavy machinery through autonomous solutions,

13 Listed in Business Finland Final report of Sustainable Manufacturing (2023) and validated also in the interviews.

sustainable power sources, data driven solutions and sustainable supply chain.

In addition, two ecosystems under the Sustainable Manufacturing program umbrella received funding from the RRF instrument after 2022:

- CaNeLis - Carbon-neutral lightweight ship structures, led by Aalto University
- MASCOT - Materials for CO2-neutral processes in resource-intensive industries, led by VTT

VTT had a prominent role as a coordinator and lead partner in most of the funded ecosystems. VTT received 13,4 M€ funding for 20 projects thorough Sustainable Manufacturing. Other key research partners often mentioned in the company interviews were Aalto University, Oulu University, Lappeenranta University of Technology (LUT) and Tampere University.

Based on the interviews, the participants were in general satisfied with the collaboration and partnerships. The co-innovation model worked well and, in many cases, also enabled learning between the companies participating with parallel projects. In a minority of cases the companies had experienced that they did not gain access to the wider ecosystem, only concentrated on their own bilateral projects with the leading research institute. It was commonly brought up that the success is largely based on the abilities of the coordinator to engage the participants in joint activities. The company projects made it possible to pilot results much faster and with lower risks. As automation and digitalisation were key focus in many activities, the projects needed possibilities to test solutions with a multitude of service providers, and the networks built enabled sharing the risks related to this phase and find common solutions.

One of the explicit goals of the program was to attract matching EU funding, and according to the final report of the program this goal was met and exceeded.

4.3 BUSINESS FINLAND AND PROGRAM SERVICES

Based on the interviews, the Sustainable Manufacturing projects and ecosystems were perceived to have been very useful for the participants, but the program brand had not created clear added value as such. Some of the interviewees noted that they did not know what program the BF funding originated from. The program was however recognised at least for a part of the interviewees as having a role in focusing funds on the important areas of automation and digitalisation of manufacturing industries.

However, interviewees did not feel they had gained specific value from being part of a program, nor did they have much experience of the program services of BF, apart from some advisory services related to their own project. One

should note that the interviews were mainly done with companies that had received RDI funding and the persons leading RDI do not usually have responsibility over marketing, sales and export activities. Interviewees at larger companies pointed out that the best overview of BF services would be found by the BF account managers, and that the RDI key people are not necessary part of the general dialogue with BF. On the other hand, interviews mentioned as a strength that the projects had succeeded in linking solution providers with key companies, enabling new products and services, business models and partnerships to form, exactly as stated in the aims of the program.

The Sustainable Manufacturing program did, however, invest significant work in different services focused on export promotion, talent acquisition, invest in activities, marketing and information dissemination. Based on data extract from BF's CRM and the final report the key activities and main observations are the following[14]:

- International RDI Promotion helping companies to utilise EU networks and funding opportunities as part of their growth strategy
- New markets and business opportunities for company groups: altogether 72 trade missions were organised in 14 targeted markets, the most important being Germany (with17 implemented projects), France, Chechia and Turkey (with >10 implemented projects each). According to the final report, the Export Promotion services engaged 170 unique companies.
- Fifteen Joint Offerings for trade promotion purposes were formed and documented on themes of mobile work machines, smart manufacturing, food and beverage industry, automotive industry, automation and robotics, carbon handprint companies etc.
- Attraction of Foreign Talent to the Industry in Finland: Three manufacturing talent Boost Workshops were arranged 2020–21 (which mostly engaged public sector participants, though)
- Invest in Finland promotion services: Key results reported were Mitsubishi Logisnext's announcement to invest in Finland, capital investments into Paptic by Itochu Fibre Ltd, capital investments into Spinnova by Suzanon, and the expansion of Binderholz facilities in Lieksa
- Marketing campaigns and media visibility: 6 media campaigns were organised with the main aim of client activation (i.e. to attract project proposals for funding services).
- Over 60 events with different purposes and formats (events, webinars, workshops, direct B2B and

14 The source for all data is BF's final report of the program, which the evaluation has validated against CRM numbers. It should be noted that the CRM data does not add up to these numbers, as CRM data for 2020–21 is insufficient. For 2022–23 the CRM finds seven delegations to six markets, and 12 joint offerings.

B2C match making), the most important being: 22 events organised by the program and 12 events in collaboration with key partners, e.g. DIMECC, Kasvu Open, SIX cluster and the Technology Industries of Finland. The program participated with keynotes etc. in 11 events fully organized by others.

- Sustainable Manufacturing had a lot of different eco-systems building activities, funded co-innovation projects, and organised for example project sparring both when applying for national RDI projects, and for EU funding applications.
- Altogether the BF CRM contains 3393 names (of which 4 foreign, Turkey) for the program.[15] The final report estimated that 1 055 Finnish companies used services provided by Sustainable Manufacturing.

4.4 RESULTS AND IMPACTS ON BUSINESS DEVELOPMENT, GROWTH AND EXPORT

The program represents a fairly focused program entity with clear targets for automation/digitalisation and sustainability/decarbonisation of key manufacturing industries in Finland. The size of the involved industries posed some challenges for creating tangible results with the available program resources, as the manufacturing industries account for around a third of both GDP and employment in Finland, a major part of the RDI investments and more

15 Note: same persons may be more than once in this list, and they have had varying roles.

than half of Finnish exports. A major part of the funding was targeted at RDI and ecosystem development, while also new products and services, and investments were created. Different results and impact categories are elaborated in the following chapters.

CREATING NEW SOLUTIONS

Based on the program final report and interviews, the program has generally been successful in reaching the direct goals set for the funded projects. The twin challenge of more efficient production and more sustainable production, with the aid of automation and digitalisation solutions was well reflected in project work. Funding enabled larger and more ambitious RDI work in different innovation and business ecosystems leading to new products and services as well as to follow-up RDI. Especially for SME's and solution providers who would not have had R&D resources of their own, reported that they had gained a lot from being included in the ecosystems of the large key companies.

The themes of the projects and their results, based on the public summaries, reflect the focus on enhancing manufacturing capabilities, sustainability, and technological advancements across wide sectors. Interviewees confirmed that the projects had resulted in new products and services, for some parts also in new business models, and paved the way for further developments.

PROCEEDING WITH INVESTMENTS TOWARDS GROWTH AND JOBS

The manufacturing industries have met huge challenges in the economic downfall the past few years. Therefore the question of how well the Sustainable Manufacturing program has succeeded in creating growth and jobs is challenging, whing was also brought up by a majority of interviewees.

Nevertheless, on the project level, interviewees could report positive development both in business development and growth and give concrete examples of jobs created as a result of the projects. It was also noted that the result indicators for the project point in the right direction, providing promising forecast on future impacts, through the developed solutions. As the markets are heavily impacted by other factors, that may weaken the overall possibilities of the program to create impact.

EXPORT GROWTH

The Sustainable Manufacturing program reports a 51% growth in export for the 170 companies that used export promotion services under the program. A clear growth in export was reported also for the 128 companies that received R&D funding from the program. Although these findings cannot directly be linked to program activities or results, interviews supported the conclusion of the final report that funding had been targeted at relevant compa-

nies and themes, and that the indicators for growth looked promising after project conclusion, which is likely to materialise in export growth over time. Many of the interviewees also reported that the R&D funding had given possibilities to initiate cooperation on new markets, which in the longer term should result in export growth.

KEY RISKS FOR FUTURE GROWTH

The key risks and obstacles for future growth mentioned in the interviews related mostly to the general development of the economy and the markets especially due to the new geopolitical environment, which challenges many Finnish companies in the manufacturing industries. Especially SMEs can find it difficult finding the resources to participate in R&D activity and ecosystem development in a harsher economic environment. Also the global development in automation, robotisation, digitalisation and AI is rapid and may result in competitive advantages becoming out of date, if development is not actively kept up at all times. The efforts of Sustainable Manufacturing especially in R&D development and Export promotion were appreciated and continuation of the work especially in the Leading Company ecosystems was highlighted as important for future growth.

4.5 IMPACTS ON DEVELOPMENT OF CAPABILITIES IN SUSTAINABLE DEVELOPMENT CHALLENGES

The program set out to solve the twin challenges of labour productivity and climate change, as well as how to preserve resilience of the manufacturing industries and Finland's economy in the era of globalisation. The high-quality resource efficiency of the sector was at the core, with automation and digitalisation as key drivers, but there was also a specific focus on decarbonisation in the program.

Interviewees mentioned automation and resource efficiency as key drivers for sustainability, which again help in developing solutions that lead to environmentally sustainable applications in different industries (like transportation). Also digitalisation and AI was frequently mentioned, enabling e.g. modelling services that will help testing sustainable solutions digitally.

4.6 SUMMARY OF REACHING THE OBJECTIVES

The headline of the program *"Global superpower of smart, sustainable manufacturing: Increased competitiveness, more high value exports, larger carbon handprint"* sums up the ambition level and scope. Sustainable Manufacturing had a fairly focused scope thematically, but due to the size of export-heavy key sectors involved, the possibilities to target the activities were considerable in relation to the available resources. This said, the conclusion of this assessment is that Sustainable Manufacturing as a whole was successful in reaching the goals, and that the project funds succeeded in attracting additional funds and creating better circumstances for business development and growth in these critical key sectors, while enhancing Finland's position in digitalised solutions. A summary of the evaluation of reaching the targets of the program is provided in Table 6.

When assessing the goal attainment of the program, it is important to consider that first the COVID 19 pandemic and then Russia's war of aggression in Ukraine affected the Finnish manufacturing industries harshly, complicating the assessment of the program's impact on the industry as a whole, but statistics show that companies involved in Sustainable Manufacturing in general were able to maintain and develop their operations despite the circumstances, which shows positive correlation between the ecosystem development and resilience of the industry.

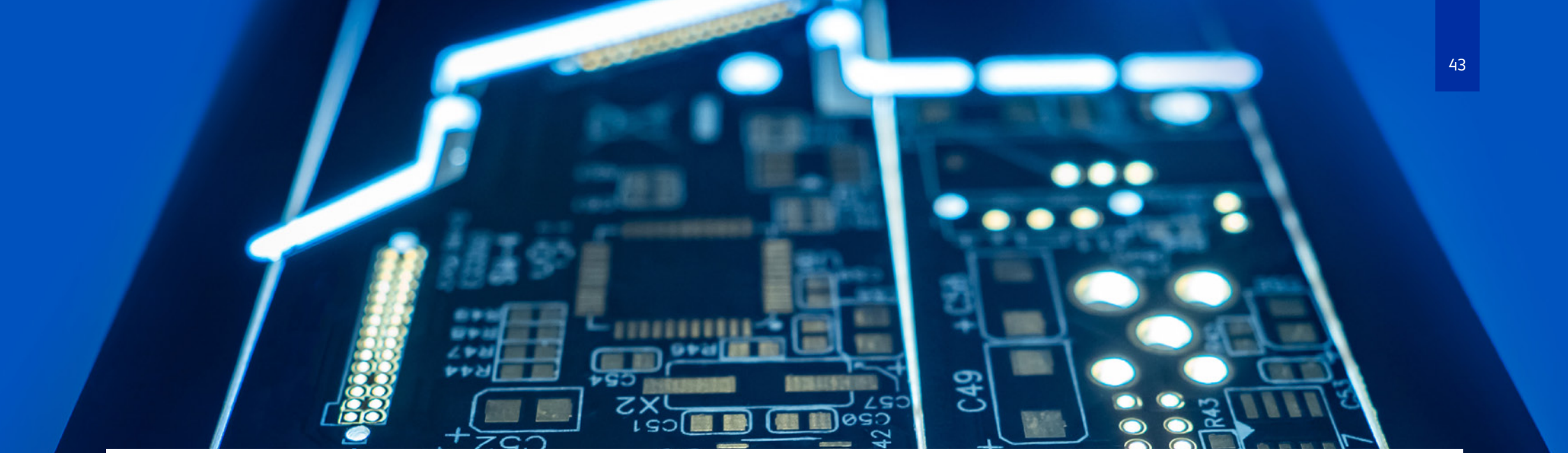


TABLE 6. SUMMARY OF THE EVALUATION ASSESSMENT OF REACHING THE GOALS OF THE PROGRAM

GOAL IN THE BEGINNING (2020)	EVALUATION ASSESSMENT OF REACHING THE GOAL (2024)	INDICATIVE GRADE (SCALE 0 – 5)
New Era of Industrial collaboration: BF funds for collaborative projects; 6-10 new disruptive manufacturing industry ecosystems; 6-10 international level pilots and demonstrations; 50 ecosystem/ test bed related SME projects per year	Based on the final report and project data this goal was very well met, with number of projects and ecosystems exceeding the target levels, and project funding of 150 M€ being matched by other funds to equal extent	very good, 4–5
Smartest Manufacturing Sector: Enabling manufacturing sector transformation through digitalization, Networked Pilot projects (5 per year), Activate SMEs to participate in EU projects	Based on the final report and project data this aim was well met, with number of projects, and accumulated EU funds exceeding the set targets.	very good, 4–5
Most Wanted Cleantech Offering: Challenge SMEs to internationalize their business and go global, create competitive joint offerings for global cleantech market, challenge large enterprises to create offerings to global markets with SMEs	Participating companies exceeded the export growth targets of 10 % per year, and with 170 companies participating, the target of engaging 100 companies was exceeded. The role of SME's in the offerings and export services is not detailed in this information, and the CRM provides insufficient data coverage for the program years.	good-very good, 3–4
Global Hub of Manufacturing Excellence: Attract investments by international companies, facilitate culture of domestic industrial investment, Attract skilled labour, experts, researchers and students to Finland, Develop practices for technology and knowledge transfer from key international hubs.	The final report highlighted some significant investments, but there is lacking evidence especially of new jobs created, and the efforts to attract skilled labour remained suboptimal, due to man reasons in the operating environment.	medium 2–3

5 EVALUATION OF THE SMART ENERGY PROGRAM

5.1 PROGRAM THEMES AND PARTICIPANTS

The energy sector is of great importance to Finnish society and economy. Energy technology accounted for approximately nine per cent of goods exports in Finland in 2015, which at the time was the second highest among the (then) 15 EU countries. The energy sector is responsible for some 25 – 35 % of Finland's total exports, and most energy products are exported to OECD countries (which accounted for 74 per cent of the value of exports in 2020)[16].

More than one third of all Business Finland funding goes to the energy sector. There are some 120 active companies in the country in this area, covering focus segments as well as whole value chains.

The Business Finland (BF) Smart Energy program (2017 – 2021) has its background in the EU decision on net-zero greenhouse gas emissions by 2050. Energy efficiency is part of the EU climate policy. It is also a part of Finland´s national climate policy, which states the aim to reduce the amount of energy required to produce services and prod-

16 Statistics Finland, 2021

ucts. Improved energy efficiency reduces CO2 emissions and energy consumption, which leads to cost savings. Resource and energy intensive industry play a crucial role.

The program aimed to support internationalisation and export activities of Finnish companies and organizations. It financed different kinds of energy-related ecosystems and testbeds, both in Finland and internationally. At the time of planning, the program was of high strategic relevance for Finland in general and for Business Finland in particular. It was to be perceived as a platform for the big picture of Finland's energy offering, and a global platform for ministries, regulators for joint development of low-carbon, smart and flexible roadmap.

It was considered important to keep Finland's top position in the energy field and strengthen new rising segments. There were three main goals (with sub-goals) of the Smart Energy program:

- Internationally attractive test platforms
  - » Significant test platforms with industry players (6)
  - » Other platforms and demos (6)
  - » Large projects of SMEs using the platforms (5 annually)
  - » SME projects as part of ecosystems (10 annually)
- Digitization of the energy sector
  - » Projects sets that aim for the internet of energy, shared with the IoT and 5th gear programs (in 5 years)
  - » Development of new business models enabled by digitization and pilot projects (in 5 years)
- Energy industry growth and international investments in Finland.
  - » Export growth of companies involved in ecosystems 5% higher than market growth on average (market growth 10% at the moment)
  - » International energy sector investments in Finland during the program approx. 300 M€ (the value of foreign direct investments in Finland at the end of 2014 was 77.3 billion, covering all sectors)

Key focus areas of the program included waste-to-value, bioenergy, biofuels, smart grids, district energy, hydrogen, power-to-X, and batteries, with a significant emphasis on digitalization as a core aspect.

At the start of the program, Business Finland had identified an opportunity span of 2–3 trillion USD in annual investments globally in Smart Energy until 2050. The main growth would take place in the emerging markets. The Smart Energy program was based on intensive co-operation with Finnish companies and organizations in international markets, and activities prioritized on company input and global market needs. The ultimate target of the program was to generate additional exports by several hundreds of millions annually.

Business Finland funded in total 287 projects with 151 755 742 €. Some 68 % of the funding (about 102 M€) went to

companies, and the largest share of that - 70 M€ out of 102 - was received by large companies, all in innovation funding. VTT received funding for 36 projects, with a total funding of close to 24 M€. The total volume of the program funding in Smart Energy was 469 M€, of which 152 M€ from BF and 317 M€ self-funding from participants. Self-funding from companies was 286 M€ and from research organisations 31 M€.

Micro companies received a sizeable share of the funding; a total of 43 micro companies received funding of close to 17 M€. One micro company, Flexens Oy Ab (see information box), was awarded BF funding for seven M€. A total of 16 of these micro companies each received funding of at least 200 000 €. One should note, however, that micro companies in the program were mostly not start-ups (see further details in chapter 5.4).

As for which industry sectors benefitted from the Smart Energy program funding, Manufacture of electrical equipment stands out with close to 28 M€ going to projects and players within that sector (See Table 5 in Chapter 2). The Manufacture of chemicals and chemical products sector attracted funding of more than 10 M€, and the Architectural and engineering activities sector slightly less than that.

5.2 STAKEHOLDER COLLABORATION AND PARTNERSHIPS

Over the time frame of the program, BF has introduced new instruments supporting industry-research collaboration and partnerships. Especially the Leading Company instrument and co-innovation project funding are visible also in Smart Energy program.

The total share of the program funding that went to research institutions was larger in Smart Energy when compared to the other two programs. Some 32 % of the funding went to 75 projects carried out by research institutions. Four research institutions dominate: Aalto university, Lappeenranta-Lahti University of Technology LUT, Tampere university and Vasa university. Aalto university headed 16 projects to a total of funding of slightly more than four M€, and LUT 14 projects with a funding of above six M€.

The interviews show examples where the Smart Energy program has strengthened existing ecosystems and created some new ones. Based on the project data it was estimated the Smart Energy supported around 20 business and research co-innovation groups of projects. The following are some examples:

Smart Otaniemi, a platform for future-bound smart city solutions that are both sustainable and commercially suc-

cessful, started in June 2020 and offered opportunities for co-creation and innovation with top companies, evolving city and cutting-edge research organizations. Several projects linked to the platform have been funded by the program. VTT, coordinator of this innovation ecosystem, describes it as a learning process where they have been able to continue with certain topics, such as EV charting tests, and piloting with companies. The headquarters for VTT is now a testbed for EV. Although no real management structure now exists, a network and a community has been created and continues.

Smart Energy Åland is a world-unique demo platform, with the goal to show that an entire society can function on 100 percent renewable energy without increasing the cost to the consumer. The objectives of the program were to find platform companies for ecosystems where the benefit would be measured in the ecosystem's success, not the companies´. The technical and economic conditions for making Åland self-sufficient in renewable energy were analysed in detail during the first years of the project, and Smart Energy Åland is now in a more operational phase working with all parts of the energy system, organized into nine focus areas.

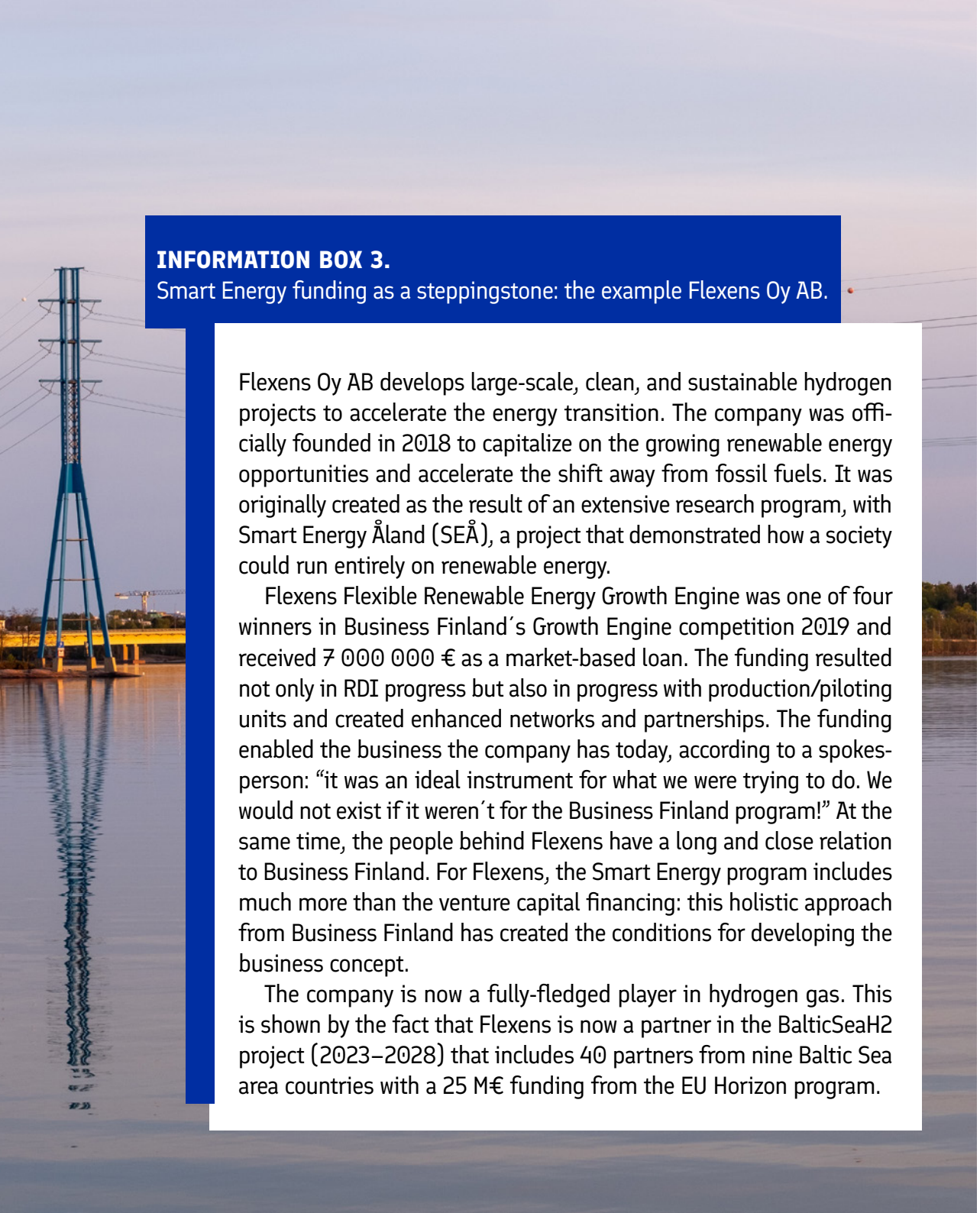
Sustainable Technology Hub (STH) plays a pivotal role in propelling the marine and energy industries towards decarbonization and the energy transition. The hub, located at Wärtsilä in Vaasa, started in 2022 and was initiated as part of the Smart Energy program The Vaasa region is the leading energy region in the Nordics, and with other key players, Wärtsilä will position STH as a leading ecosystem of collaboration.

The different research areas and ecosystems were structured in the program to Carbon neutral electrification (example GreenE2), Smart & Flexible energy systems (e.g. Smart Energy Åland/Flexens), and Circular economy of energy (e.g. BATCircle which is linked also to Bio and Circular Finland program).

Several big energy companies, such as ABB, Fortum and Valmet with projects funded in the Smart Energy program also have Leading Companies funding.

Three ecosystems that received funding from RRF instrument:

- CIRP-5G - Centralized Intelligent and Resilient Protection Schemes for Future Grids Applying 5G, Vaasa University in collaboration with ABB, Järvi-Suomen Energia Oy, the interest organisation for Finnish energy companies Sähkötutkimuspooli, and the Finnish software company Wapice
- FinnH2- Finnish runway to hydrogen business, lead VTT, LUT, Aalto University in collaboration with 18 stakeholders from various industries
- IFORGE - ICT for Resilient Green Electrification, Aalto University



INFORMATION BOX 3.
Smart Energy funding as a steppingstone: the example Flexens Oy AB.

Flexens Oy AB develops large-scale, clean, and sustainable hydrogen projects to accelerate the energy transition. The company was officially founded in 2018 to capitalize on the growing renewable energy opportunities and accelerate the shift away from fossil fuels. It was originally created as the result of an extensive research program, with Smart Energy Åland (SEÅ), a project that demonstrated how a society could run entirely on renewable energy.

Flexens Flexible Renewable Energy Growth Engine was one of four winners in Business Finland´s Growth Engine competition 2019 and received 7 000 000 € as a market-based loan. The funding resulted not only in RDI progress but also in progress with production/piloting units and created enhanced networks and partnerships. The funding enabled the business the company has today, according to a spokesperson: "it was an ideal instrument for what we were trying to do. We would not exist if it weren´t for the Business Finland program!" At the same time, the people behind Flexens have a long and close relation to Business Finland. For Flexens, the Smart Energy program includes much more than the venture capital financing: this holistic approach from Business Finland has created the conditions for developing the business concept.

The company is now a fully-fledged player in hydrogen gas. This is shown by the fact that Flexens is now a partner in the BalticSeaH2 project (2023–2028) that includes 40 partners from nine Baltic Sea area countries with a 25 M€ funding from the EU Horizon program.

Based on the interviews, the participants have been satisfied with the collaboration and partnerships. The company projects made it possible to, for example, test the results directly with the customers and along the value chain.

The interviews show that the projects have strengthened already existing networks and collaborations to a larger extent than creating new ones. There are, however, examples of where projects have helped to build up new networks. One interviewee explained that project developers in the industry are the best way to get return on the knowledge created in the ecosystem as a whole.

5.3 BUSINESS FINLAND AND PROGRAM SERVICES

Based on data from BF's CRM the following observations can be made:

The Smart Energy program invested significant work in different services focused on export promotion, talent acquisition, invest in activities, marketing and information dissemination. Based on data from BF's CRM the following observations can be made:

- New markets and business opportunities for company groups: The program organised ten delegation

visits to support export, of which eight were virtual ones (to e.g. Canada, China, Germany, Indonesia, Thailand, Turkey, UAE)
- A total of 158 virtual delegation events reported in the CRM were carried out
- The program arranged 210 network building events
- Over 30 events with different purposes and formats (events, webinars, workshops, direct B2B and B2C match making). The webinars for example were used to disseminate results from separate market and technology studies ordered by BF and events organised in connection with the business delegation visits
- 34 specific "meet the buyer" events were held
- The Smart Energy program had a lot of ecosystems building activities, funded co-innovation projects, and two specific ecosystem programs (EBCC P2X - CO2 emission reductions by modular power-to-X technologies, NIEI ECO-SMR)
- Altogether CRM contains 1108 names (of which 12 foreign) for the program.

The interviews carried out indicate a high degree of satisfaction concerning the services provided by Business Finland in which the interviewee´s company has participated. The Smart Energy projects and ecosystems were perceived as very useful, but their being part of a program or benefitting from a program brand appear not to have created clear added value as such. Some of the interviewees noted that they did not know what program the BF funding originated from. In any case, the Smart Energy funding played a significant role in focusing funds on important thematic areas such as hydrogen, energy efficiency in buildings and batteries. Several interviews emphasized the digitalization aspect.

Networking opportunities and non-funding export promotion services receive specific positive mentioning by some interviewees. Most interviewees mentioned as a strength that the projects had succeeded in linking solutions providers with key companies and end users, enabling new or enhanced networks and partnerships to form. In some cases, this had an effect on new products or services and new business models. Several interviewees note that Business Finland is active and helpful in this respect, at the same time as a couple of others give more critical views noting that Business Finland did not have a good understanding of the companies' needs (market information services provided superficial information), or that Business Finland was not really active in involving the ecosystem in other services (like invitations to present the activities or participate in delegations). One interviewee describes how "Business Finland fosters discussions between different countries, creates business opportunities" and does this well, but understands this as not being derived directly from the Smart Energy program.

These services, however, are mainly seen as "Business Finland standard operating procedures" rather than as

unique or specific for the Smart Energy program. Based on the interviews, the Smart Energy program does not appear to have had a clear identity. As reflected upon earlier for the other programs evaluated, one reason for this is the wide scope of the program. The interviewees tend to be more knowledgeable about certain Business Finland services rather than the program as such. They are aware that their project received funding by the Smart Energy program, but the added value created lies less in the program as such but rather in the funding opportunities it provided. Interviewees are aware it reflects the new instruments supporting ecosystems of which many are large programs on their own (e.g., Leading Company programs). As in the case of the other programs, the interviews were mainly done with the companies which received RDI funding and the persons leading RDI do not usually have responsibility over marketing, sales and export activities.

5.4 RESULTS AND IMPACTS ON BUSINESS DEVELOPMENT, GROWTH AND EXPORT

CREATING NEW SOLUTIONS

Based on interviews, the program has generally been successful in reaching the direct goals set for the funded projects. For most interviewees, the project has resulted in RDI progress (new innovations and progress with technology) and New / enhanced networks and partnerships. Progress with production / piloting units (investments) and Increased export / sales are also reported by a majority.

The public project summaries highlight the following often mentioned technology areas that the projects focus on, relevant for more than two projects:

- **Biogas and Biomethane Production:** Example: Metener Ltd is developing new biogas upgrading solutions to meet the biomethane standard EN 16723-2 and to process low-quality biogas for better fit in CHP and heating applications.
- **Electric Powertrain and Energy Efficiency:** Example: The Smart Otaniemi initiative focuses on optimizing electric drives and hydraulics for non-road applications, aiming for energy-efficient solutions and digital twins for real-time monitoring.
- **Carbon Neutral and Fossil-Free Steel Production:** Example: The FFS project aims to transition to electricity and hydrogen-based steel production to significantly reduce CO2 emissions, involving research on carbon-neutral steelmaking processes.
- **Smart Energy Solutions and Ecosystems:** Example: The Smart Otaniemi project serves as a living lab for testing and piloting smart energy solutions, integrating various domains like buildings,

transport, and communication.

- **Waste Heat Recovery and Conversion:** Example: A project is developing a scalable engine for converting low-grade waste heat to power, focusing on customer piloting and commercial applicability.
- **Printed Electronics and Smart City Applications:** Example: The project aims to integrate printed electronics into infrastructures, enhancing sensor capabilities for applications in smart cities, such as monitoring environmental conditions.

These areas reflect the focus on innovative technologies aimed at achieving carbon neutrality and enhancing energy efficiency across various sectors. The areas, and the projects, also reflect a strong focus on sustainability.

PROCEEDING WITH INVESTMENTS

Smart Energy program funding focused on the RDI and did not provide investment support for the companies. The longer-term impacts on society, however, only take place through investments in the energy transition. Confederation of Finnish Industries (EK) maintains a database of green investments[17] and many of the future investments are targeted to Smart Energy areas. Especially the hydrogen sector investments are expected to boom over the next decades although most of the projects are in the early planning phase and some have discontinued in autumn 2024. A recent study ordered by EK together with other industrial associations examined the impacts of green investments on GDP, taxes and jobs in detail giving some indication of the potential longer-term impacts on the economy of some Smart Energy areas[18].

The progress of the investments depends on many factors and there are a lot of uncertainties. Interviews show that companies have shifted their focus or scope of services due to external factors, such as for example market behaviour, the pandemia or regulatory issues.

Here, the developments in the area of hydrogen need mentioning. Smart Energy funded projects in this area to the amount of 16 M€. The hydrogen economy, that is, the roles hydrogen can play alongside low-carbon electricity to reduce emissions of greenhouse gases, is a growing area in Finland and elsewhere. Recent developments, with the Neste decision to re-evaluate its renewable hydrogen plan and withdraw from investing into a 120 MW electrolyzer at the Porvoo refinery and Ørsted´s decisions to abandon wind-powered green hydrogen projects and focus on wind energy projects with green hydrogen only as a complementary technology and to close down plans to produce e-methanol using renewable hydrogen from wind power, is

17 **Green investments in Finland - Elinkeinoelämän keskusliitto**
18 Gaia Consulting (Sweco Finland) (2024) **Loppuraportti_Vihrean-siirtyman-investointien-vaikutusten-arviointi-1.pdf**

not good news for the development. There are headwinds in the industry, and investment decisions will be made with different schedules than previously envisioned.

FOCUSING EFFORTS

There was an overlap between Smart Energy program and other Business Finland programs and initiatives. This program was one funding source among others, but it served to focus Business Finland´s efforts on certain areas and topics. The program, as programs in general tend to do, managed to rally the troops around the same agenda, uniting forces.

The program focused on world-class companies, and those with an expanding business. Then the focus was on clean energy production, and on areas where the market is not working (rather than mature technologies or markets). This approached facilitated Finland being early on the battery stage; the European battery alliance was launched in 2017, and Finland began in 2018 a systematic approach for a battery value chain and the battery program was established. This can be seen, at least in part, as a result of having the Smart Energy program. The developments around smart grids and links to ICT activities and digitization were also influenced by what was achieved through the Smart Energy program.

START-UPS AND FUTURE GROWTH OPPORTUNITIES

As indicated in chapter 5.1., a lot of micro size companies participated in the Smart Energy program. Further analysis was done to identify the start-up companies among these 40 micro enterprises. The companies that were less than five years old at the time of the start of the program were filtered among the micro companies. The clear daughter companies, companies founded by a group of companies (e.g. Flexens Oy) or large multinationals and not-growth seeking small companies were excluded. Each company was then further assessed based on the public financial information and their web pages as well as through the interviews. In total, there were around ten start-up companies. The reviewed companies are thus now in 2024 a maximum of ten years old and they have varying growth stories. Compared to the Bio and Circular program group of start-ups, the progress looks much slower. Most of the start-ups in the Smart Energy program were more technical consultancy-based, and the growth has been moderate or have stopped. There are, however, about five companies at the bigger growth path. such as Geyer Batteries Oy, QHeat Oy and Vensum Power Oy.

The program supported internationalization and exports, but no concrete volume information of the increased export is available. The interviews indicate that the impact of the

program on export has been moderate, at the same time as some give evidence of projects leading to increased export. Based on the interviews, SMEs use the Business Finland's export support services to a relatively limited degree. Those who have used these services, however, show appreciation.

EXPORT GROWTH

Concrete volume information of the increased export is not available. Qualitative evaluation data and some individual quantitative company data show evidence of growth and international investments. Based on the interviews, BF's export support services have been used only to a moderate extent, and the same goes for the projects´ contribution on export.

KEY RISKS FOR FUTURE GROWTH

The following key risks and obstacles for the future growth came up in the interviews.

- **Market Responsiveness:** Changes in the market, particularly due to market behaviour and geopolitical events like the Ukraine war, can impact demand and operations. The development in the hydrogen sector is a case in point. Some interviewees point to the importance investing with a longer perspective, but this is less of an opportunity for some companies.
- **High Technology Risks:** There is often uncertainty regarding the development of commercial products and connected services, particularly in the transition from pilot plants to full-scale production. Technology development and investment in RDI are needed.
- **Financial Challenges:** The financing instrument is a loan that must be repaid. A long delay in the market introduction could be a problem, especially for small companies. A loan on the balance sheet is a concern in the upcoming financing round.
- **Talent Acquisition:** Attracting the best competences from a global talent pool may hinder project execution and innovation. This was mentioned by several interviewees, Nuclear energy is an obvious case in point. There has been a long gap when no new reactors were built, and now a lot is happening in Europe at the same time. Most people who championed it then are now retired: a lack of competence means a risk of wrong prioritizations of funding.
- **Flexible instruments**. How can we find ways to exploit early ideas, when the topics are identified, and companies are interested? There is a need to build a showcase, and then find incentives for everybody to join, not only those with expectations to export. These systems need to be built in Finland first, then invite others. It would be valuable to find processes for how this could work. Foreign companies may be very interested in piloting in the Nordics. but they need to know why, who, when, what?

Interviews show examples where projects funded by the program helped companies revise and shift their business focus, and in some cases also to expand their interest in a studied area. Interviewees also provide examples of risk avoidance as a result of project findings. In one case, the main takeaway (and an important one) from a project was the learning: the market is not going where the company expected it to when the project started. This made the company decide on a strategy change, not to participate in one of the areas studied in the project. It saved the company from dedicating further resources and running too far in one direction.

5.5 IMPACTS ON DEVELOPMENT OF CAPABILITIES IN SUSTAINABLE DEVELOPMENT CHALLENGES

The project portfolio show that a large majority of the projects have sustainable development as one focus area (among others). The interviews also clearly highlight the sustainable development aspect, with comments such as "It is important in everything we do and propose" and "This is all about sustainable development!". Sustainable development is often seen as going hand in hand with customer interests and commercial concerns. Energy efficiency is mentioned as an important driver by several interviewees, exemplified in one case by a digital platform for building information management and in another by decommissioning as important for ensuring that nuclear energy is sustainable. One company points to the significant role of the project in the transition from fossil based to renewable energy, as it combined key expertise of companies in Finland and took it to neighbouring markets.

5.6 SUMMARY OF REACHING THE OBJECTIVES

In several aspects, the Smart Energy program has been successful. Smart Energy solutions have created new and/or enhanced business ecosystems with opportunities to lead to radical changes in the roles of producers, service providers and consumers. Smart Energy funded energy-related ecosystems and testbeds in Finland and abroad in areas of national priorities. These ecosystems have created opportunities for SMEs to enter the energy market, and to interact fruitfully with larger companies and research institutions, some of them outside of Finland. In several cases, that is now happening. To which extent these have speeded up internationalization is, however, not possible to determine; the funding from the Smart Energy program is only one (and mostly not the primary) factor influencing this.

The program helped building the positions Finland now has in certain areas. The battery program and the 2021 national battery strategy put Finland in the forefront, and

issues related to hydrogen emerged. Finland and Finnish companies participated in the first Important Project of Common European Interest (IPCEI) on batteries (2019) and the second (2021), as well as in the first IPCEI on the first and second IPCEI on hydrogen (both in 2022). Finland achieved a strong position in European value chains, and the Smart Energy program was important for that and made Finland more attractive as a destination for investments. The program created confidence for domestic and international investors.

Smart Energy projects have resulted in RDI progress and concrete advances in products and production technologies including also new innovations. This has been of significant value to several large companies. A sizeable number of micro companies received funding. Although the growth of the start-ups funded has been moderate or have stopped in a majority of the cases, there are about five companies at the bigger growth path.

A project portfolio analysis shows that the main areas funded by the program reflect the focus on innovative technologies aimed at achieving carbon neutrality and enhancing energy efficiency across various sectors. The areas reflect a strong focus on sustainability. Areas which are less prominent are new products/services and new business models.

It can be stated that the goals of the program have been met well, on a more general level. A large number of projects were funded in areas that at the time of planning were of high strategic relevance for Finland in general and for Business Finland in particular, such as waste-to-value, bioenergy, biofuels, smart grids, district energy, hydrogen, power-to-X and batteries. Digitization was often a cross-cutting theme.

It should be noted that this evaluation could not validate the results and valuations of a final program report, since such a report does not exist.

A summary of the evaluation of reaching the targets of the program is provided in Table 7.

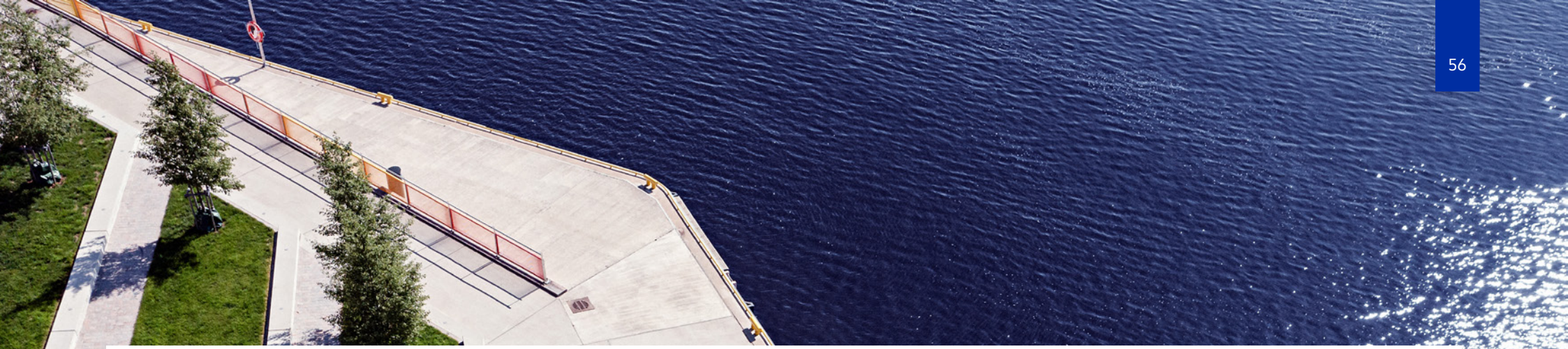


TABLE 7. SUMMARY OF THE EVALUATION ASSESSMENT OF REACHING THE GOALS OF THE PROGRAM

GOAL IN THE BEGINNING (2017)	EVALUATION ASSESSMENT OF REACHING THE GOAL (2024)	INDICATIVE GRADE (SCALE 0 – 5)
Internationally attractive test platforms • Significant test platforms with industry players (6) • Other platforms and demos (6) • Large projects of SMEs using the platforms (5 annually) • SME projects as part of ecosystems (10 annually)	Test platforms have been created and continue after the funding period. SMEs are part of the ecosystems, and there are examples of large SME projects using the platforms. It has not been possible to verify if the quantitative targets have been reached. A large majority of the funded projects are in the focus area of development of business ecosystems.	Good, 4
Digitization of the energy sector • Projects sets that aim for the internet of energy, shared with the IoT and 5th gear programs (in 5 years) • Development of new business models enabled by digitization and pilot projects (in 5 years)	Digitization is a focus area of a large majority of the projects funded by the program. The first sub-goal is not possible to verify. New business models is an area less prominent in the project portfolio, but there is qualitative data showing evidence that new or revised business models enabled by digitization and pilot projects are being implemented.	Medium to good, 3–4
• **Energy industry growth and international investments in Finland** • Export growth of companies involved in ecosystems 5% higher than market growth on average (market growth 10% at the moment) • International energy sector investments in Finland during the program approx. 300 M€ (the value of foreign direct investments in Finland at the end of 2014 was ~~7~~7.3 billion, covering all sectors)	The Smart Energy program was one among many other factors and funding opportunities affecting export growth and inward investments. The program helped building a strong position for Finland in certain areas of strategic and commercial interest. It also helped strengthening what Finnish actors can offer in these areas and made Finland more attractive as an investment destination. Qualitative evaluation data and some individual quantitative company data show evidence of growth and international investments. However, a lack of overall quantitative data regarding industry export and growth impedes validation of the sub-goals.	Medium to good, 3–4

6 CONCLUSIONS ON THE RESULTS, IMPACTS AND ADDED VALUE OF THE PROGRAMS

The evaluation of Smart Energy (2017–2021), Bio and Circular Finland (2019–2022) and Sustainable Manufacturing (2020–2023) provided a good opportunity to assess three programs that shared many features, but also some differences in approach.

The three programs were among the first ones to be conducted under the new Business Finland organisation, combining R&D funding with a broader portfolio of services for business development, export, and growth. The programs also shared the general aims to solve sustainable development challenges while boosting the growth and internationalisation of Finnish businesses, and therefore provide an interesting case for comparison.

The scope and participation in the programs differed both due to the aims set out at the beginning of the program, and the structure and state of the involved sectors at the time of program development. Bio and Circular Finland had the broadest scope, the highest funding volumes, and project numbers, and also provided an interesting case for studying the role of Business Finland's support to new and emerging businesses. The Smart Energy program

focused heavily on developing an internationally attractive platform of Finnish energy offering and had the highest share of R&D funding targeted at cooperation between research organisations and businesses. The Sustainable Manufacturing program focused to a high degree on coupling service providers and key manufacturing industries in Finland to develop new and more resource-efficient solutions and had the highest participation of mid-cap and big companies.

THE ADDED VALUE OF BUSINESS FINLAND PROGRAM SERVICES

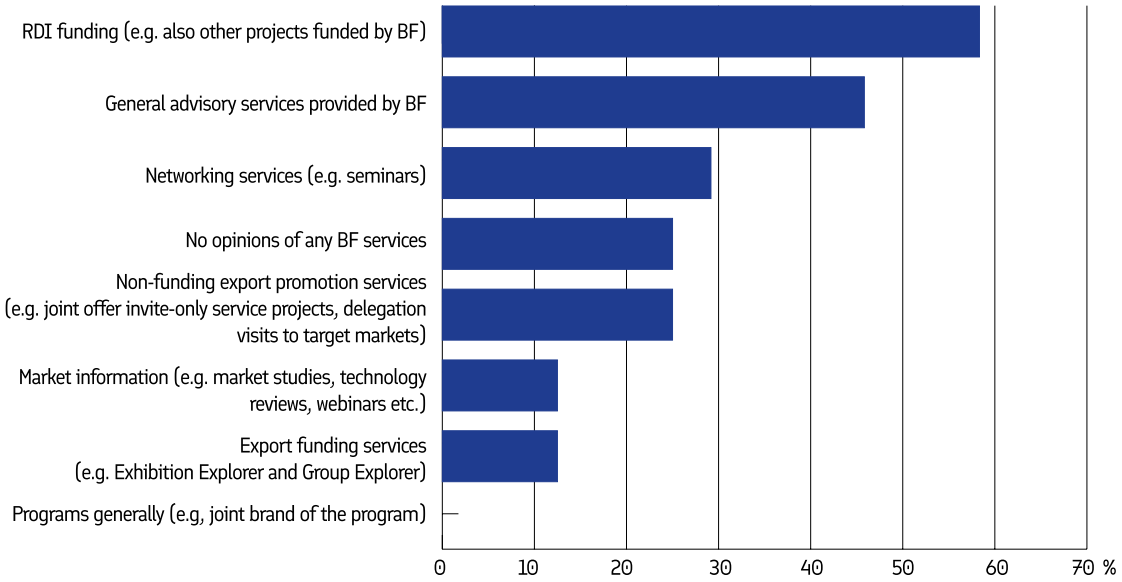
All of the three programs were implemented at the time straight after the integration of Tekes and Finpro into the new Business Finland organisation and were among the first programs to combine R&D funding with a larger portfolio of export and invest-in services.

The final reports of the programs and available CRM data show a wide range of program services and their use including trade missions and delegation events (including virtual), joint offerings, invest-in services, networking events, and marketing campaigns and media visibility. However, the evaluation detects little synergies within the participating companies between these activities and the R&D funding activities. This is especially emphasised in interview findings, and partly due to the fact that most interviews were conducted with business representatives responsible for R&D, who had not participated in the export services. As such, it is not surprising that R&D activities and export services have mostly been used by different company representatives and for different parts of the companies offerings. However, the fact that different parts of the program have worked in separate tracks has had a diminishing effect on the perceived program identity and brand value.

For Business Finland itself, thematic programs have undoubtedly been a useful way of targeting funding towards important themes. However, the interview results indicate that the program value towards at least R&D customers has diminished over the past few years, as companies refer more to the instruments or their own projects and ecosystems, than to the thematic programs. This is not necessarily a weakness, as the evaluation shows that programs and leading company ecosystems have been used in a smart way together and co-innovation projects and Leading company initiatives have helped reach the targets of the programs. Even though the interviewees' experience of the full scale of program services was limited, the feedback received on Business Finland's services was in general positive, and Business Finland advisors and global network (dedicated contact persons) received for most part good ratings.

A full evaluation of the added value of different program activities is difficult, partly because the CRM data does not cover the full period of these programs and has not been

collected in a consistent way, allowing for valid analysis. The challenges related to combining a multifaceted portfolio of services under a program umbrella and the risks of losing the program identity is an interesting finding that could be further explored when planning future activities. To be able in the future to fully assess the added value of program services and of programs as such in Business Finland portfolio, it is important to have sufficient and comparable CRM data available.



Number of respondents: 24, selected answers: 50

FIGURE 3. BUSINESS FINLAND'S SERVICES MENTIONED IN THE INTERVIEWS. ALL PROGRAMS TOGETHER. INTERVIEWEES WERE ABLE TO MENTION MORE THAN ONE SERVICE THEY HAD EXPERIENCE WITH.

THE ADDED VALUE OF STAKEHOLDER COOPERATION ON ECOSYSTEM DEVELOPMENT AND SCALING OF ACTIVITIES

Combining forces through stakeholder collaboration is essential to increase both resource-efficiency and the handprint of Business Finland. The evaluation shows that the programs have been successful in strengthening the ecosystems, and also in supporting the creation of new ones.

Several ongoing Leading Company initiatives, as well as other central ecosystems, were established and accelerated under the umbrella of the three programs. Additional funding, especially the investment support from RRF instrument, brought added value to the ecosystem development.

Research organisations had a dominant role in orchestrating ecosystem development. The evaluation does not show any clear findings on how much ecosystem development in these programs has been driven by company interests vs researchers interests, but participants were in general satisfied with the collaboration and partnerships and highlighted the coordinators' role in orchestrating effective network cooperation both with the whole network, and in bilateral company projects.

Sector-coupling, combining different kinds of companies in ecosystems, was seen as one of the main added values

of the BF funding. The co-innovation model worked well with clear synergies and coordination among projects but also enabling parallel company projects. Company projects made it possible to, for example, test the results directly with the customers and along the value chain and across different value chains at best, projects made it possible to pilot results much faster, sharing the risks and finding common solutions.

One interesting question that this evaluation could not dwell upon in depth, is the role of BF funding for maintaining already established ecosystems, and when are the ecosystems at a point where they function without this support.

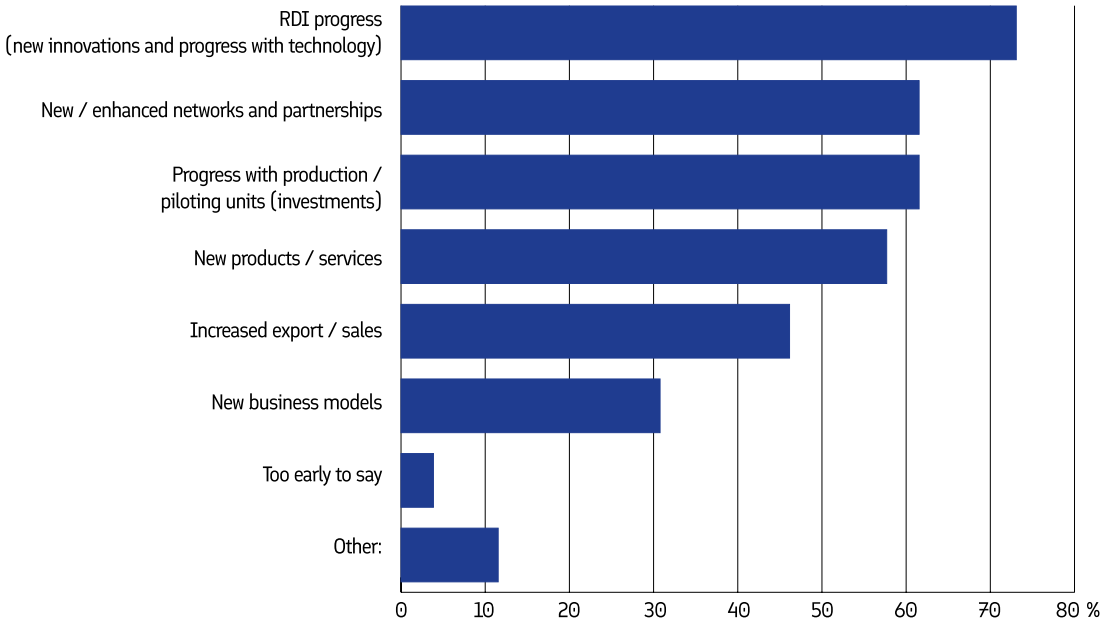


FIGURE 4. MAIN DIRECT RESULTS FROM THE PROJECTS MENTIONED IN THE INTERVIEWS. ALL PROGRAMS TOGETHER. INTERVIEWEES WERE ABLE TO MENTION MORE THAN ONE RESULT. NOTE THAT INTERVIEWS WERE MADE MAINLY WITH RECIPIENTS OF R&D FUNDING.

IMPACTS OF THE PROGRAMS ON BUSINESS DEVELOPMENT, GROWTH AND EXPORT

The programs were in general successful in reaching the direct goals set for the funded projects. The funding enabled larger and more ambitious RDI work in different innovation and business ecosystems leading to new products and services as well as to follow-up RDI. For SMEs the support was crucial for developing new solutions. In the Bio and Circular Finland and Smart Energy programs, the participation of start-ups was analysed, and especially within the Bio and Circular program there were many research-based start-ups that have used a variety of BF services.

When it comes to the role of Business Finland in enhancing longer-term impacts on business development, growth and exports, the evaluation indicates that projects have had good results, even though a full impact evaluation would need some deeper analysis at a later stage. As an exception one can look at the startups in Bio and Circular

Finland, where there is already evidence of direct impact of the BF activities.

Interview results strengthen that indications for positive longer-term impacts were found especially in business development and internationalization. The use of export services was at a good level in all of the programs, but that does of course not answer the question of the impact of these activities on export and markets growth. The R&D projects had for natural reasons little direct impact on export, as these typically realise at a later stage in the impact chain.

Business development and growth is highly dependent on diverse market factors outside the reach of Business Finland activities, and even if available statistics show correlation between program participation, growth and export, no direct assumptions can be made based on this data as to the contribution of Business Finland to this growth. The three evaluated programs were in addition realised at a time of global pandemic and geopolitical crises, which again may have had negative effects on the programs' potential to create impact, However, *at project level* interviewees reported positive indications of longer-term impact of the activities and brought up good examples of how the projects and ecosystem collaborations had helped them maintain activities and avoid further cutdowns. The contribution of the programs on jobs is somewhat more problematic to assess, as many of the sustainability solutions

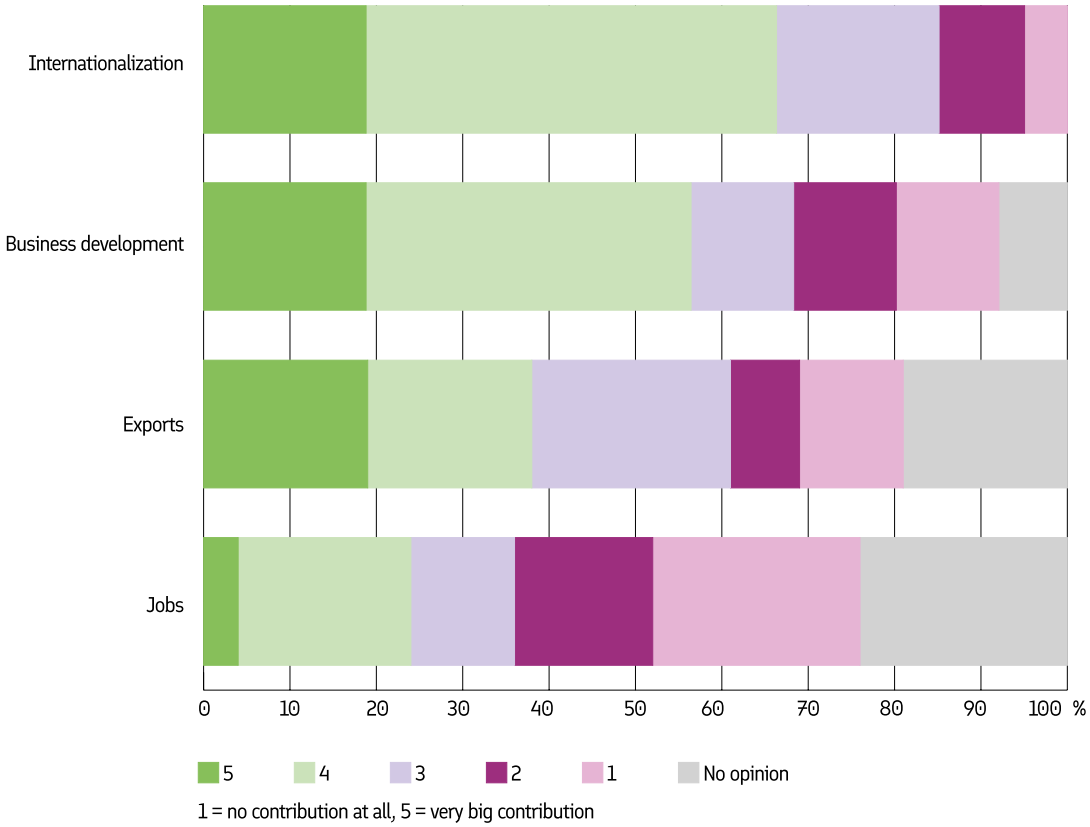


FIGURE 5. INTERVIEWEES' OPINIONS OF THE IMPACTS OF THE PROJECTS. ALL THREE PROGRAMS TOGETHER. N = 26. NOTE THAT INTERVIEWS WERE MADE MAINLY WITH RECIPIENTS OF R&D FUNDING.

targeted at digitalisation and automation may also reduce the need for human workforce in specific operations.

All in all, Business Finland's role was seen as instrumental. Concerns regarding future development brought up in interviews were for most part related to general market responsiveness, risks of losing the competitive edge in rapidly developing markets, high technology risks, financial challenges, challenges related to talent acquisition. Positive development was often realized as continued cooperation in business ecosystems (such as Leading company ecosystems) after the program had been discontinued.

Sustainability was an integral part of the aims of the three programs, alongside business development and growth. The key themes of the programs were targeted at building capabilities for sustainable development and funding was specifically targeted at companies that look for sustainable solutions. The project summaries highlight key drivers for sustainability, but with a clear focus on environment and climate perspectives. Also, the interviewees saw sustainability as natural integral part of the projects, hand in hand with competitiveness and good business. The overall impacts of Business Finland on the development of capabilities in sustainable development challenges can therefore easily be overestimated. It is however safe to say that the programs have played a role in helping sustainability-driven companies to accelerate solutions for the markets.

LEARNINGS FROM THIS EVALUATION ON HOW TO BUILD ADDED VALUE THROUGH PROGRAMS

This evaluation shows that the three programs Smart Energy, Bio and Circular Finland and Sustainable Manufacturing were products of their time, and each of the programs has tried to answer to the real needs and aims identified at the time they were planned. This has been reflected both in the targeting of funding and in the use of other program services under each program. Despite some identified challenges with combining so different services under the same program, the activities have clearly been designed out from an understanding of the needs of the sectors at the time the programs were developed, with the aim to best serve business development and growth. It is therefore not possible from the results of the evaluation to give any categoric advice on a suitable scope for Business Finland programs. Each program probably needs to be tailored in the future as well, considering a) aims of the activities, b) thematic width and breadth to target, b) number and size of the most potential target customers, and their typical challenges, d) range of instruments and services to be used, and where to put the main focus, and so on. One interesting question for further consideration may be what the role of programs, as a way of targeting various instruments and services on specific aims and themes, will be in the new mission-based thinking of Business Finland, and whether this role will further decrease, remain intact, or even increase.

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